

**A study on academic search engines:  
Comparison between dynamic queries and regular faceted search**

by

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## ABSTRACT

Dynamic queries interfaces provide a powerful and fun way to search information. Using this technique with a faceted navigation can be very effective for academic researchers who are often engaged in exploratory searches. Facets can play an important role in helping the user understand an information space better. Dynamic queries techniques make the search results immediate and the interaction uninterrupted and focused. They can contribute to the user's understanding of the researched topic(s). Furthermore, they are more playful because users directly manipulate controls and the results are displayed through transition animations, which bring the process closer to a game experience (e.g., moving a slider that rearranges the available products).

The study compares for the first time (to the researcher's knowledge) regular faceted search to dynamic queries specifically for academic content. Two academic search engines were developed and compared: a regular faceted interface and a dynamic queries interface. Several strengths and weaknesses were identified in both systems. The dynamic queries prototype has the potential to deliver a greater experience with the appropriate back-end technology and design considerations discussed in this thesis.

## CHAPTER 1. INTRODUCTION

Academic search has changed immensely with the advancement of new technologies such as the Internet. Information has become widely available through free and online databases. This has created a dramatic increase of the use of online resources and declining use of physical libraries (Niu, Hemminger, & Lown, 2010).

Changes in the research process and advances in web search have created a trend where students and faculty have come to expect immediacy when looking for information related to their studies. They want to have the ability to instantaneously see results and bring up the content item (Niu, Hemminger, & Lown, 2010). Online search tools are also very attractive to scholars because of their ease of use. However, their use is not so suitable for users with ill-defined information needs, as is often the case with people in academia. Researchers' main goals are primarily to gain a deeper understanding of the topic of interest, as well as to form hypotheses that require further studies. In this type of search process, exploration and learning are major factors.

The goal of the presented thesis is to investigate new and existing interaction techniques that can facilitate online academic literature exploration. Chapter 2 reviews published research related to library and web resources and their use. It also looks at several studies of established and more unconventional interaction techniques that can improve scholarly searches. The literature review focuses on the following questions:

- 1. What are current search methods that support exploratory search?*

*2. What other interaction techniques are there to improve search efficiency and the user experience of scholarly researchers?*

It was found that *faceted search* interfaces are prevalent in online information access systems, and specifically for e-commerce (Tunkelang, 2009). This type of search is also implemented in some online library systems. A faceted interface combines keywords entry and browsing through the use of a faceted navigation. It allows users to progressively refine their queries and also learn more about the explored topic(s) by providing an overview of the information (Tunkelang, 2009; Dörk, Carpendale, Collins, & Williamson, 2008).

Another technique explored in Chapter 2 is called *dynamic queries*. It is a new form of interaction that has the potential to improve faceted interfaces for scholarly searches.

Dynamic queries give the user the ability to formulate queries rapidly and in a playful way by using widgets and viewing immediate results (Shneiderman, 1994). In addition, dynamic queries continuously update the search results when users manipulate the interface, which establishes a sense of control over the database (Shneiderman, 1994). The discovery of this interaction style through review of the literature raised the following research questions:

- 1. How effective is dynamic queries search interaction compared to regular faceted search interaction in delivering results and helping the learning process?*
- 2. Does dynamic queries search interaction improve the user experience for academic searchers?*

To answer these questions, two prototypes of a library search interface were developed and tested with subjects. Both systems use facets and keywords. However,

Interface One is based on dynamic queries interaction, while Interface Two implements a traditional approach to faceted search. Chapter 3 of this thesis describes the methods used to conduct the study. In Chapter 4 the results are displayed and discussed. Finally, Chapter 5 analyzes and concludes the study, in addition to charting future directions for this research.

## CHAPTER 2. LITERATURE REVIEW

### 2.1 Demands and Expectations of Academic Researchers

Academic research has changed dramatically with the advancement of new technologies like the Internet. In the past, researchers relied almost solely on the physical libraries to find resources pertinent to their studies. They browsed books, journals, magazines, and consulted with librarians. This process might have been rewarding but it took a significant amount of time.

The Internet, this vast network of connected computers and almost infinite sources of information, has become an incredible force that has also impacted academic research. In a study at Carnegie Mellon University, interviews with graduate students confirm this phenomenon (George, Bright, & Hurlbert, 2006). The study discovered that the Internet was the primary search source for a majority of graduate students and most notably business majors (91%). The web was considered “extremely useful” and a primary search tool. Another survey of faculty and staff at Cornell University from 2003 found that a majority of participants (73%) were using the web for searches on a daily basis and half as many used library websites (Poland, 2004). In 2003 and 2004, a survey of more than 25,000 students, faculty, and staff also identified that a large number of researchers used Internet search engines in their studies (60-67%).

The Carnegie Mellon University study discovered that one of the main reasons why students are using physical library resources less, according to participants, is their preference for convenience, especially when they need something instantly (George, Bright, & Hurlbert, 2006). Hur-Li Lee also confirms students’ choice of convenience (Lee, 2008). A

majority of students in her study indicated that an Internet search is usually their first step into the search process (Lee, 2008). Participants also preferred Internet searches because no physical trip or browsing of shelves was required from them. They could just do it conveniently from their home.

It can be argued that students and researchers today have become accustomed to the convenience of online sources and take it for granted. They plan their time and execution of research with that in mind. In other words, spending time looking at books and journals in the library is no longer something on the agenda for many people in academia. This can explain the demand by many students for more electronic delivery of research materials. Receiving digital copies of literature was also indicated as top choice by the Cornell University student survey (Poland, 2004). This furthers the idea that technology and the Internet have become not only a convenience but also an expectation.

Contrary to popular belief, the survey described by Lippincott and Kyrillidou, shows that faculty use web search engines as much, and even more, than students (Lippincott & Kyrillidou, 2004). This finding suggests that the overwhelming use of Internet search engines is not isolated to students who have grown up with the technology, but is an overarching phenomenon. It can be argued that it is the qualities and nature of the search engines, and not generational aspects, that stimulate their use. That brings up the question, what are the qualities, besides ease of access, that attract users to web search engines?

## 2.2 Web Search Engines and Ease of Use

One of the key features of web search engines is their ease of use, which is one of the primary reasons for their popularity among users. Most sites like Google, and more recently

Google Scholar, offer users a simple interface (a text search box) that is at the same time very powerful in retrieving data.

Lee's interviews with undergraduate students pointed to ease of use as a big plus of Internet search engines, and specifically Google (Lee, 2008). Students were generally dissatisfied with library tools for online search. They found them confusing because of their complexity. The complexity, as established by Capra, Marchionini, & Oh (2007), is caused by the constant growth of information from online resources available through the libraries. This increase poses great challenges to organizing the information. While physical libraries have spatial boundaries to structure data (rooms, shelves), digital libraries do not. Therefore, library interfaces become cluttered and hard to use (Capra, Marchionini, & Oh, 2007). Google and other web search engines, on the other hand, are much simpler and offer an easy to use alternative to students.

Google Scholar, as described by Ettinger, gives the user the simplicity that is so commonly referred to when speaking of Google, and the notion that scholarly content is being retrieved (Ettinger, 2008). It is almost as if Scholar gives users that extra confirmation that the results come from reliable resources. People feel “safe” using content obtained through the search engine.

In the study described by Tanya Cothran, which surveyed the graduate population at University of Minnesota, participants rated Google Scholar's ease of use high (Cothran, 2011). They considered the interface to be clean and simple. Subjects in her study also perceived Scholar to be useful. They believed that the search engine helps them in their research.

York identifies that a majority of searchers prefer to use Google and Google Scholar for discovering topics and ideas (York, 2005). However, they still rely on library resources, such as library databases, to obtain trustworthy materials. But the simplicity and speed of Scholar gives it an edge and makes it preferable for students and faculty when they have the “desire to explore and survey information.” (York, 2005)

As studies show, library institutions are still considered relevant and are in use by students and faculty. In the study by George and colleagues, most graduate students (78%) relied on the university library databases along with Internet searches (George, Bright, & Hurlbert, 2006). Jamali & Asadi (2010) show that the vast majority of students prefer to use article index databases when searching for scholarly articles in particular. Libraries provide reliable scholarly materials and all the resources needed to conduct research: journal and magazine subscriptions, books, article database subscriptions, etc. The resources are numerous, so why don't researchers take advantage of them?

### 2.3 Challenges with Online Library Resources

In the study by Lee (2008) participants pointed to the online version of their library as their second choice of resource searching but also expressed their dissatisfaction with the large amounts of resources and tools it offered. The abundance of information and the countless channels of academic materials can make it really overwhelming for a searcher, especially somebody lacking the experience of scholarly search. In the same study, students were very critical of the complexity of the library tools and services. There was much confusion about indexing databases: what those are, how to use them, which ones to use.

Online libraries of higher education institutions offer a lot of article databases to

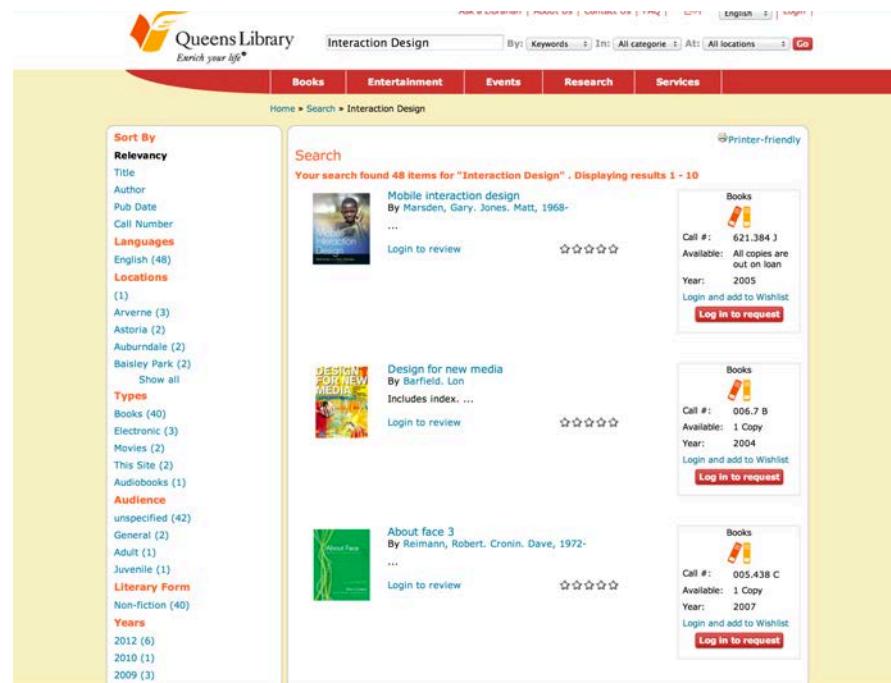
cover all researchers' needs. However, most of those are very specific to a field of study. PsycINFO, for example, contains resources mainly about the areas of psychology and human-computer interaction. For technology and engineering, researchers might use ACM's Digital Library, EBSCO, etc. These databases, while highly rich in literature related to the represented fields, limit the searcher to the specific area of study.

Web search engines, however, search across a variety of resources. The interviews conducted by Jamali & Asadi (2010) showed that one of the most valued benefits of Google as a search engine is that it is not limited to a specific research domain. It indexes everything that is available online. Interviewed students also pointed out they considered the search engine a good "point to start". For the most part they agree that it gives them a quick overview of an area that they may not know much about. Moreover, if researchers use Google Scholar, they will receive results that index everything containing the keywords entered in the search box. Scholar conducts a federated search across multiple databases. Arguably, as Ettinger (2008) demonstrates, using the search engine can produce better results. They may provide more inter-disciplinary results by spanning multiple areas of study.

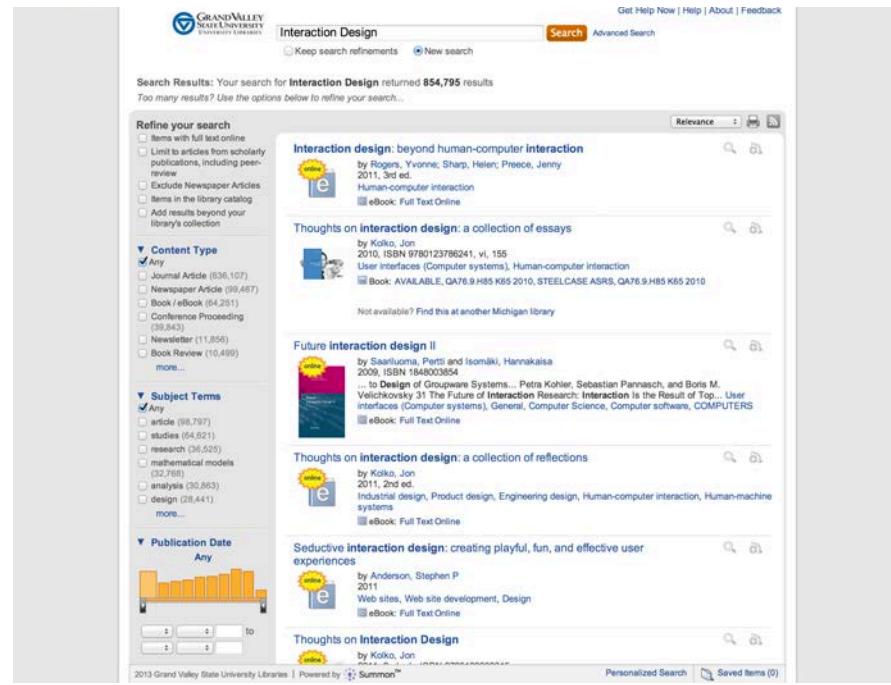
Libraries and database publishers, however, are not standing idle. There are on-going efforts by institutions to deliver search systems to students and faculty that allow for a federated search across all available library resources. A lot of higher education establishments have recently become clients of search systems that aim to do exactly that.

Currently, the market for fully integrated library search solutions is fairly rich. Aquabrowser (Fig 2.1) is a customizable library search engine solution and in 2010 it was used by over 800 libraries worldwide. Encore (Fig 2.2) by Innovative Interfaces is another

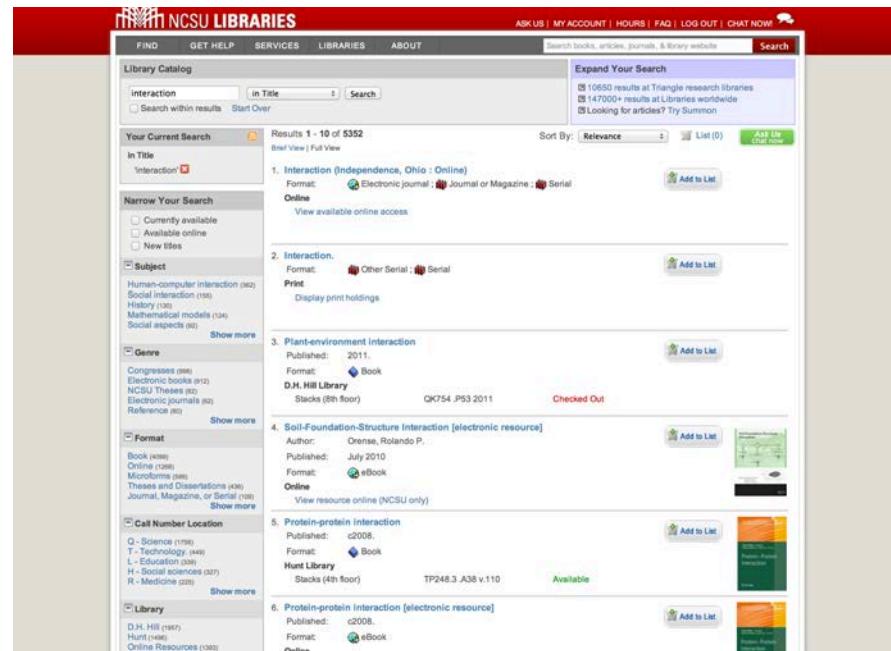
library search engine service, which promises to integrate “everything the library has to offer”. Endeca's technologies (Fig 2.3) are being used by a wide variety of e-commerce industries but have also been adopted by research institutions like North Carolina State University. Ex Libris' Primo (Fig 2.4) promises to be a one stop shop for “delivery of all local and remote scholarly information resources, including books, journals, articles, images, and other digital content.” (Nagy, 2011)



**Figure 2.1.** AquaBrowser on the Queens Library website.



**Figure 2.2.** Encore on the Grand Valley State University website.



**Figure 2.3.** Endeca on the NCSU Libraries website.

The screenshot shows a search results page from the University of Tennessee's library system. At the top, there are tabs for 'Books Plus' and 'Articles', and a search bar with the query 'Interaction design'. Below the search bar are filters: 'All items' (with a dropdown for 'that contain my query words'), 'Search' (with a dropdown for 'anywhere in the record'), and 'Advanced Search'. To the right is a 'AskUsNow!' button with 'Chat Online' and a link to '1-10 Next +'. A yellow banner at the top says 'Did you mean: interior design?'. On the left, there is a sidebar titled 'Refine My Results' with various filters: Topic (Computer Science, User Interfaces and Human Computer Interaction, Human-computer interaction, Information systems, Information Systems Applications (incl. Internet)), Collection (University Electronic Library, Hodges Library), Resource Type (Books, Other, Journals), Language (English, French, German), Creation Date (Before 1980, 1980 To 1989, 1989 To 1997), Creator (SpringerLink (Online service), Pandu Rangan, C., Tygar, Doug., Naor, Moni.), Classification LCC (Q - Science, T - Technology, L - Education, R - Medicine, Z - Bibliography, Library science, Information resources (general)), and more. The main results area shows 568 results for 'All UT Libraries Collections'. The first result is 'Sonic Interaction design' by Karmen Franinović and Stefania Serafin, published by The MIT Press in 2013. It includes links for 'Available', 'Hodges Library Stacks', 'Check Locations tab for other copies', and 'View Map'. Below it are other results like 'Thoughts on interaction design : a collection of reflections' by Jon Kolko, 'Acting with technology [electronic resource] : activity theory and interaction design' by Victor Kapelin, and 'Inventing the medium [electronic resource] : principles of interaction design as a cultural practice' by Janet H. Murray. Each result has a small thumbnail, title, author, publisher, and a row of buttons for 'Locations', 'Details', 'Items', 'Reviews & Tags', and 'Additional services'.

**Figure 2.4.** Primo on the University of Tennessee website.

Along with companies developing library solutions, there have also been some open source efforts in this market. VuFind, released by Villanova University, is an open source library search solution that has been adopted by many institutions around the world (Nagy, 2011). All of these solutions have their unique features but one thing they have in common is they all use a combination of lookup (typing keywords in a search box) and browsing interaction. The benefits and challenges of this search method are in the focus of the presented thesis.

## 2.4 Lessons Learned from Google Scholar

Part of this thesis research aims at discovering what academic search tools are most popular among students and faculty, what makes them popular, but also what limitations they

pose on scholars. Google and Google Scholar, as noted previously in this chapter, are among the most popular choices because of their ease of use and ability to retrieve results related to multiple disciplines. Unlike Google, Google Scholar provides users with more scholarly content. Scholar's team claims it indexes major academic research sources, but their indexing techniques have not been disclosed. Ettinger indicates the lack of transparency in the inclusion criteria for the content. This is also the criticism of most library scholars about the search engine (Ettinger, 2008).

Aside from this, Scholar is quite powerful and considered a great tool especially in the beginning of the research process to “see what's out there”. But is the search engine savvy enough to support some academic research “heavy-lifting”? The simplicity of Google Scholar is its advantage but can also be seen as its downfall. The main action available is entering keywords into a search box. That is about all the search interaction the user gets. However, relying only on keyword searches is a great limitation. As Ettinger points out, the lack of additional features surprises more advanced searchers and it limits them in their endeavors (Ettinger, 2008). In this sense Scholar is more suitable for quick lookup and “casual” searches than actual in-depth research.

Callicott & Vaughn (2005) argue that Scholar can serve only as an introduction tool for new researchers. Its capabilities are very limited for more advanced searches. Experienced researchers expect to have much more control over the results. Scholar's lack of “comprehensive search options” is also another reason why some users visit library/scholarly databases where these types of options exist in some form or another (York, 2005). Furthermore, by not providing stronger tools, very often users stop the search and choose to use the obtained results even though the results may be below satisfactory. Callicott and

Vaughn point out that librarians and instructors have observed how students are content with only mediocre results because Scholar discourages thorough search (Callicott & Vaughn, 2005). In the worst case scenarios, the search engine can discourage people from exploring deep into a topic and stimulate instead meager results.

Students confirm their desire to have more advanced tools available to them as part of the search engine in the study by Lee (2008). Some students expressed a need to be able to narrow down results, which is something that is missing in web searches and Google Scholar. Some of the interviews indicated that browsing was very helpful for students when they were not initially familiar with a topic and the task at hand (Lee, 2008). They described their use of classified book stacks in the library for exploring different topics. This type of exploratory browsing is lacking on the web, as search engines do not provide robust tools to support it.

Google Scholar users, without a particular search target, may be forced to constantly refine their keywords because of the lack of more sophisticated search options. This in the end may not yield very satisfying results. Such lookup mode of search interaction is perfect for obtaining quick facts and it yields precise results, if the query string used in the search box is very refined (in library circles, this type of information retrieval is called “known-item”). Most researchers, however, especially in the beginning phases of research, want to explore the information space to form their hypothesis. They are in exploratory search mode, which is discussed below.

## 2.5 Exploratory Search

A lookup action is not suitable for solving complex search problems, where it is necessary to look at several different view points/materials to get a better picture of a

problem. It is also hard to conduct a search in this way, if one is not familiar with the knowledge domain and/or is unsure about his/her goals. However, this type of interaction, as stated previously in this literature review, is wide spread on the web (Google, Yahoo!, Bing) and has become the standard (White & Roth, 2009). People have come to equate “search” on the web (and on a computer in general), as using a search box and keywords.

Marchionini argues that the lookup search action is a “turn-taking” model: the user inputs a query of keywords, hits “enter” and waits for the system to respond with related results (Marchionini, 2006). If the retrieved items are not relevant or more resources are needed, the user repeats the action until the search goal is achieved. Marchionini points out that there is a need for a better model, where the user is much more involved and in control of the search process (Marchionini, 2006).

Lookup actions retrieve documents that are well-structured but only answer direct questions, such as “what” happened “where” and “who” was involved (Marchionini, 2006). Lookup tasks are appropriate when the goal of the search is well-defined (Capra, Marchionini, & Oh, 2007). The results can be highly accurate. However, lookup actions become insufficient when the goal of the search is a deeper understanding of an issue or an area of study, where the questions become “how” something happened and “why” it happened (Marchionini, 2006).

In exploratory search, finding a specific piece of information is not the main goal. Rather, it is to build knowledge about the subject/topic. When users are involved in this type of search, they experience “more complex cognitive processes” (Capra, Marchionini, & Oh, 2007). Users analyze, synthesize, and compare the information to build their understanding

(Capra, Marchionini, & Oh, 2007).

Wildemuth & Freund (2012) describe exploration as the “investigation and examination of something in order to learn about it and make discoveries.” This is also valid for exploratory search, where the user “investigates” and “examines” the information space in order to “discover” and “learn” about new topics/subjects related to his/her final search goals. The authors point out that “learning” and “investigation” are the primary goals of exploratory search, which is confirmed by the information retrieval community.

Searching to learn is far more complex than lookup. As Marchionini (2006) points out, it requires multiple attempts at querying and using multiple search tools. In addition, the user needs to analyze and process the retrieved information using critical thinking skills. These “learning” search tasks are best executed when there is an interaction that combines both browsing techniques and lookup search strategies (Marchionini, 2006; White & Roth, 2009).

Academic researchers are a perfect example of a user group where this could prove extremely resourceful. They often have vague or not well-defined ideas about a topic or a research area of interest. Exploratory browsing can help them refine or expand their research. This is also confirmed by previously stated studies where browsing was found very helpful by students when they did not have much knowledge of a topic and/or the assigned task (Lee, 2008).

## 2.6 Exploratory Search Systems (ESSs)

White & Roth (2009) define the main goals of exploratory search systems (ESSs) as to provide a variety of tools to users to facilitate their learning and investigation during the

search process, and also to guide them in their quest of exploring uncharted territories. In exploratory search, people learn from exposure to the information by exploring collections and the objects within them. Consequently, it is important for an exploratory search system to summarize the information in appropriate categories that can be understood and explored by the user.

Unlike lookup search systems, exploratory search systems are designed to help users with vague information needs. In other words, when a searcher does not know what he/she is looking for, an ESS provides the tools needed to obtain that kind of knowledge. A system of this type gives more power to the searcher by providing interfaces that can be easily manipulated (White & Roth 2009). It supports Marchionini's vision of exploratory search, who advocates for a search model, in which the user is much more involved and in control (Marchionini, 2006). The users can learn and investigate issues and topics that are new to them, which makes the system become an "intelligence amplification" (White & Roth, 2009).

### **2.6.1 ESS Features**

White & Roth (2009) discuss some eight key features for a powerful and successful ESS. For the purposes of this research, features one, two, four, and five were examined. The first focuses on giving users the ability to refine their queries and the ability to do it rapidly. The authors emphasize the importance of designing interactions that allow searchers to narrow down the results, so they can reach more relevant parts of the information space. White and Roth are advocates of the idea of dynamic queries and discuss their great potential, which comes from allowing users to generate and continuously view rapid results

by using visual tools like sliders and filter widgets. White and Roth conclude that dynamic queries can be very beneficial for hypothesis generation by exploring the data simultaneously on “multiple dimensions”.

Another feature they consider essential is a faceted navigation. The facets represent metadata related to the searched objects and can be used to represent the data in a meaningful way. Furthermore, a faceted navigation can help filter desired results and explore the collection. This research explores its use for academic search purposes.

White and Roth (2009) argue for the visual representation of available data. They claim it stimulates searchers' insight and helps them take the next steps in conducting their exploration. Visual representation is also a factor that was considered for the thesis study by representing the amount of resources available per facet (resource count). In addition, the impact of these features on learning and understanding was examined. White and Roth (2009) identify learning and understanding as primary goals for exploratory searches.

Kules & Shneiderman (2008) describe several design guidelines for future exploratory search systems. Out of the eight main points, several were factors in the thesis research. They emphasize that information lives within a context and it is beneficial for the user to visualize it. One way to do it is by representing the information hierarchy. This can be done by showing category items as children or parents of others in a hierarchical or a breadcrumb navigation. A better understanding of the information space could mean better search results and ultimately, better learning.

Kules & Shneiderman (2008) demonstrate the importance of “tight coupling” of categories and search results. They show that by directly linking the two, searchers see

results quickly and are able to better understand the meaning of the categories (specifically when the categories use unknown terms) and how the results relate to them. When implementing this feature, Kules and Shneiderman (2008) emphasize the importance of showing what category is selected, so it is not overlooked.

The most widespread version of an exploratory search system is faceted search, which combines both lookup and browsing. This type of search allows the user to narrow down the results through the use of metadata representation of the documents. It supports some of the key features of an ESS described by White & Roth (2009). It also gives the user an idea of what is available to him/her and therefore, improving context awareness, a design guideline which was discussed earlier (Kules & Shneiderman, 2008).

### **2.6.2 Faceted ESSs**

A faceted search interface combines both lookup and browsing interaction. The browsing actions are facilitated by a faceted navigation. Faceted navigation breaks away from rigid information structures and represents the data on multiple levels using metadata. This has the potential to paint a better picture of the data collection, how it is distributed, and how data artifacts relate to one another. Faceted navigation, according to Tunkelang (2009), can guide users through the search process by allowing them to continuously refine their queries by selection instead of constantly entering new keywords.

Facets can classify documents by topic area, author (of an article), time of publication/upload, price (for a product), etc. Facets are a type of metadata organization of information, where data can be stored in multiple “storage bins” (Capra, Marchionini, & Oh, 2007). A document in a physical library can be put in only one spot such as a shelf. In

contrast, its electronic version can be represented by multiple facets, and therefore has multiple ways of reaching it (Capra, Marchionini, & Oh, 2007).

Faceted search has found place in both academia and e-commerce. In e-commerce, in particular, this type of search has a strong following. It has been implemented by many major websites/services like eBay and Amazon. The section below discusses further details about how faceted ESSs are applied to online sales.

### **2.6.3 Faceted ESSs in E-commerce**

Faceted search interaction is highly applicable to e-commerce sites because product attributes can be represented through facets: price, size, weight, etc. (Tunkelang, 2009). Therefore, faceted navigation systems are ubiquitous in electronic sales. One can just look at the two giants, Amazon and eBay, to see how this is implemented and try out its effectiveness.

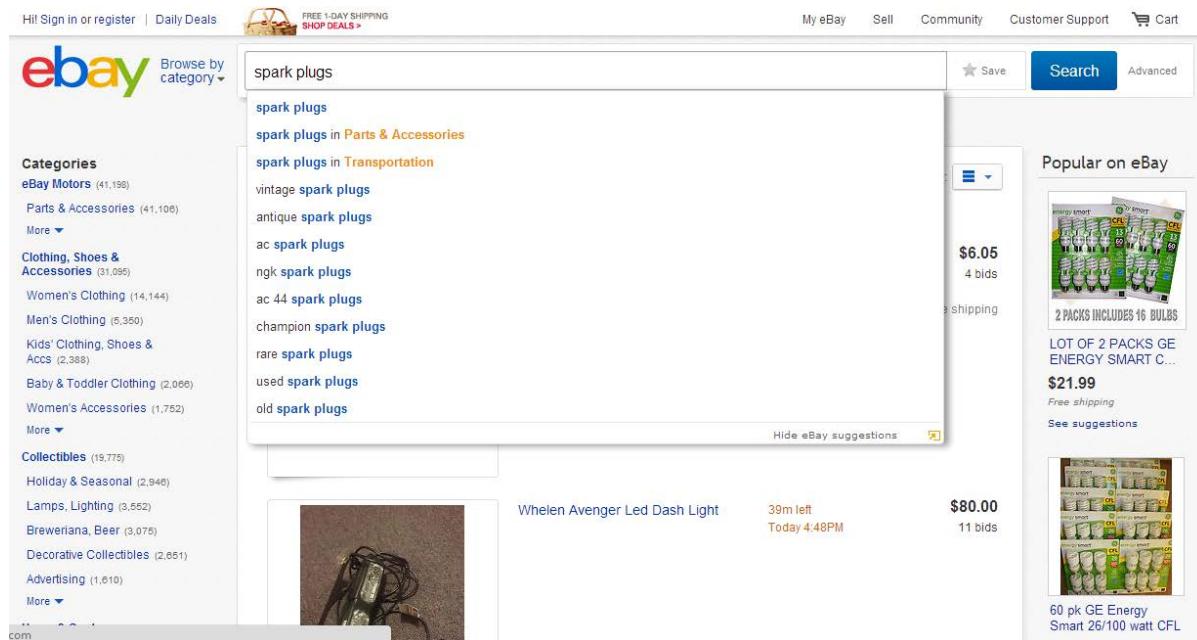
#### eBay

eBay is a company whose website allows users to browse, bid, and purchase products. It is extremely popular and relies heavily on search interaction. eBay is a prime example of using faceted navigation combined with a search box.

In its version during the time of writing this thesis, the website displayed the following characteristics. As soon as the user first comes to the site, the homepage displays a prominent search box, as well as a browsing navigation. The visitor is immediately given two choices of search interaction, browsing or keyword search, which stimulates the exploration process. As the user types in a query, a drop-down menu with query suggestions appears (Fig

2.5). This is convenient for the searcher, as it may help pinpoint the appropriate information space he/she wants to search. It also helps when the user is not sure about the spelling or about the name of the sought item.

After the query is submitted, the user is sent to a response page. The page layout supports the typical faceted search layout: faceted navigation in a left panel, keyword search box at the top, and result section in the center. This layout, as Tunkelang notes, gives the search results more prominence, and therefore, they are the first thing users notice (Tunkelang, 2009). Each listing in the results section contains an image of the item, item name, auction time, and item price. The faceted navigation displays the following facets: Categories, Format, Condition, Price, and Location. Of these five, only Categories contains links only, the other facets are presented through check boxes or a slider (Fig 2.6).



**Figure 2.5.** Prominent search box with dynamic keyword generation.

\$9.99), 'PAIR OF ANTIQUE SPARK PLUGS' (>\$19.99), and '8 Vintage Champion Spark Plugs #7 (esta...' (>\$17.75). A sidebar on the right shows 'Popular on eBay' items."/>

The screenshot shows the eBay search results for "spark plugs" within the "Transportation" category. The left sidebar contains facets for "Categories", "Format" (with "Auction" checked), "Condition" (with "New", "Used", and "Not Specified" options), and "Price" (ranging from \$0.99 to \$1,120). The main search results show three items:

- MONTGOMERY WARD RIVERSIDE SPARK PLUGS 4 TOTAL** - \$9.99, 0 bids, 26m left, Today 4:25PM. Image shows four spark plug boxes.
- PAIR OF ANTIQUE SPARK PLUGS** - \$19.99, 0 bids, 24m left, Today 4:23PM. Image shows two antique spark plugs.
- 8 Vintage Champion Spark Plugs #7 (esta...** - \$17.75. Image shows eight vintage champion spark plugs.

A sidebar on the right lists "Popular on eBay" items, including "Champion Spark Plug Plastic Champion..." for \$24.99 and "8 Vintage Champion Spark Plugs #7 (esta..." for \$17.75.

**Figure 2.6.** eBay facets and results screen.

As the user checks the facets on or off, the results change (expand or contract based on inclusion criteria). The checkable facets act as filters and conveniently show up in the results list as labels. The labels are removable, which allows users to unfilter the displayed data set (Fig 2.7). The Categories facet, its sub-categories and attributes, are represented by links. The system displays the number of items for each category, which gives the user a good overview of the data set (Fig 2.8). This type of overview supports the idea of White & Roth (2009) to represent the data visually to stimulate the searcher's insight.

With each Category facet selection, a drill-down into the data occurs, which is also a desirable feature of an ESS (White & Roth, 2009). The results section displays only items of that category. The selected category is indicated in the faceted navigation and in the search

bar but there is no indication of category hierarchy. The user has no information about parent categories, which can potentially cause confusion. Showing the category hierarchy is important for building context around the information and is one of the requirements for a search system of this kind (Kules & Shneiderman, 2008).

When a searcher wants to enter a new search query, he/she has the option to search within the current category (default, represented with a tag in the search bar), or the entire database by removing the category label (Fig 2.9). In other search interfaces, the search bar simply resets the search and returns results related to the new query.

The screenshot shows the eBay search interface. The search bar at the top contains the query 'spark plugs'. Below the search bar, there are several filters: 'Auction' (highlighted with a red box), 'New', and 'Clear All'. To the right of the filters, there are sorting options ('Sort: Best Match') and viewing options ('View: List'). The main search results area displays two items:

- Lodge Spark Plugs HN**: \$6.00, 1 bid, 1h left (Today 4:38PM)
- Four (4) NGK 6240 (PLFR5A-11) spark plugs - New In Box / No Reserve / FREE SHIP**: \$22.49, 3 bids, 1h left (Today 5:00PM), Free shipping

On the left side of the page, there is a sidebar with categories like 'eBay Motors' (1,185), 'Parts & Accessories' (1,185), 'Collectibles' (123), and 'Home & Garden' (80). At the bottom of the sidebar, there is a 'Format' section with a checked checkbox for 'Auction'.

On the right side of the page, there is a vertical sidebar for 'eBay Buyer Protection' with the text: 'covers your purchase price + original shipping' and an 'e' logo. Below this, it says 'It's FREE and already included with'.

**Figure 2.7.** eBay result filters.

Related searches for spark plugs : [champion spark plugs](#) [spark plug sign](#) [spark presario v 6000](#) [spark plug wires](#)

**Categories**

- [eBay Motors \(1,185\)](#)
- [Parts & Accessories \(1,185\)](#)
- [Collectibles \(123\)](#)
- [Transportation \(95\)](#)
- [Advertising \(19\)](#)
- [Militaria \(4\)](#)
- [Tobacciana \(1\)](#)
- [Sewing \(1930-Now\) \(1\)](#)
- [More ▾](#)
- [Home & Garden \(80\)](#)
- [Yard, Garden & Outdoor](#)

**1,528 active listings | sold listings | completed listings**

Auction  New  Clear All


Lodge Spark Plugs HN

**Figure 2.8.** Facets overview

Sign in or register | Daily Deals FREE 1-DAY SHIPPING [SHOP DEALS](#) My eBay Sell Community Customer Support Cart

**eBay** [Browse by category](#) spark plugs in Transportation  Advanced

Refine your search for spark plugs

**Categories**

- Transportation
- Automobilia (301)
- Motorcycles (15)
- Aviation (2)
- Trucks (2)
- Boats & Ships (1)
- Bicycles (1)

**Format** [see all](#)  Auction

**Condition** [see all](#)  New  Used  Not Specified

**Price** [customize](#) \$0.99 - \$1,120

		Sort: Best Match	View:
	MONTGOMERY WARD RIVERSIDE SPARK PLUGS 4 TOTAL	26m left Today 4:25PM	\$9.99 0 bids
	PAIR OF ANTIQUE SPARK PLUGS	24m left Today 4:23PM	\$19.99 0 bids
	8 Vintage Champion Spark Plugs #7 (esta...)		\$17.75

**Popular on eBay**

**Figure 2.9.** Displaying that category label in the search bar

The eBay interface has some irritating aspects. As the user selects the facet filters or the categories, the page has to constantly reload, which sends the user at the very top each time. This creates an effect of disorientation, as the user is forced to scroll up and down to find his/her previous spot. In addition, when categories are selected, there is a lack of hierarchy representation. Thus the user is partially losing information context.

### Amazon

If one compares Amazon to eBay, a lot of similarities can be pointed out. Amazon is also an example of using faceted search navigation in combination with a search box to deliver data about desirable items. Submitting the query takes the user to a results page, the layout of which is again standard for faceted search: the left panel is reserved for the faceted navigation, there is a keyword search box in the header, and results are displayed in the center. The navigation contains facets, such as “Department” and “Shipping Option”, as well as facets that are strictly related to the items in the search results (when a query for “flash drive” was submitted, this generated a “Capacity”, a “Feature Keywords”, and a “Feature Brands” facets). The facets are represented by a combination of clickable links and check boxes that generate a new results list (Fig 2.10).

The screenshot shows the Amazon search results for 'flash drive'. At the top, there's a navigation bar with links for 'Your Amazon.com', 'Today's Deals', 'Gift Cards', and 'Help'. On the right, there's a 'Hello, Sign In Your Account' button and a 'Join Prime' button. A Valentine's Day banner is visible in the top right corner. Below the navigation, there's a search bar with the query 'flash drive' and a 'Go' button. To the left of the search bar, there's a dropdown menu for 'Shop by Department' with 'Computers' selected. The main content area shows a breadcrumb trail: Electronics > Computers & Accessories > Computer Accessories > New > Kingston or PNY > Under \$25 > "flash drive". Below the breadcrumb, it says 'Showing 1 - 24 of 87 Results' and 'Sort by [Relevance]'. There are three product cards displayed:

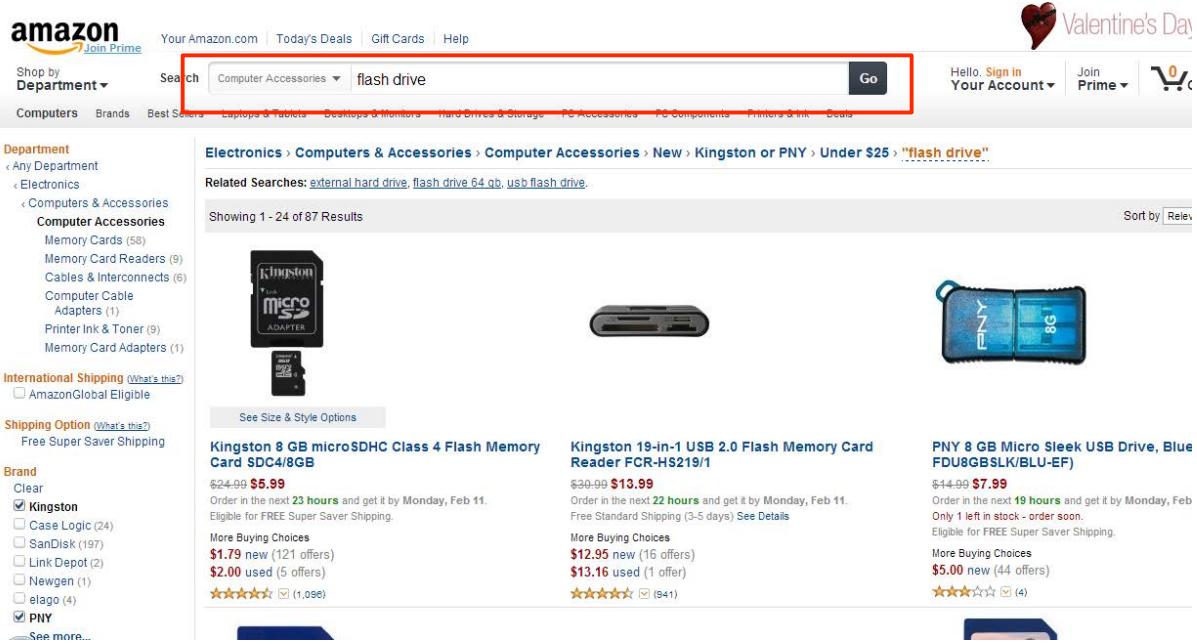
- Kingston 8 GB microSDHC Class 4 Flash Memory Card SDC4/8GB**: Price: \$24.99, Sale Price: \$13.99. Order in the next 23 hours and get it by Monday, Feb 11. Eligible for FREE Super Saver Shipping.
- Kingston 19-in-1 USB 2.0 Flash Memory Card Reader FCR-HS219/1**: Price: \$30.99, Sale Price: \$13.99. Order in the next 22 hours and get it by Monday, Feb 11. Free Standard Shipping (3-5 days). See Details.
- PNY 8 GB Micro Sleek USB Drive, Blue FDUG8BSLK/BLU-EF**: Price: \$44.99, Sale Price: \$7.99. Order in the next 19 hours and get it by Monday, Feb 11. Only 1 left in stock - order soon. Eligible for FREE Super Saver Shipping.

On the left side of the page, there's a sidebar with facets for 'Department' (with 'Computer Accessories' selected), 'International Shipping', 'Shipping Option' (with 'Free Super Saver Shipping' selected), and 'Brand' (with 'Kingston' selected). The 'Brand' section also includes a link to 'See more...'.

**Figure 2.10.** Amazon facets: the facets are represented by a combination of clickable links and check boxes. The current category is represented hierarchically, with the parent categories still available for selection.

As the user clicks or checks any of the facets, the navigation changes but most of the facets, specifically ones that contain check boxes, continue to display all the other options under the facet. Unlike eBay, the “Department” facet, which represents the product category, shows the hierarchy of categories. This allows the user to easily go back a level or two and also gives him/her information context, one of the guidelines by Kules & Shneiderman (2008). One can argue that it also provides the searcher with a better view, or a “mental map” (Norman, 2002), of the information space. In addition, using a breadcrumb-type navigation above the search results further contributes to the display of product hierarchy. The two elements form a solution that is significantly better compared to eBay's approach, where categories are selected and the facet changes its content to display only the current category plus its sub-categories. Thus the user loses the full overview of the information space.

Similarly to eBay's interface, when a department category is selected, the website displays that category label in the search bar. The user then can form a new query and search within that same category (Fig 2.11).



**Figure 2.11.** The website displays that category label in the search bar.

Although Amazon's faceted search interface allows for better interaction with the information space, there are still some limitations to the current version. When the user selects facet filters or department categories, the page has to reload, thus initializing the interface to begin at the very top. This is counter productive and one can argue that it contradicts with the important principle of “tight coupling” of categories and results described by Kules & Shneiderman (2008). Before users are able to see examples of their selection, their screen changes, which interrupts the association of selected option and

results.

#### **2.6.4 Faceted ESS Studies**

The implementation of faceted search among e-commerce systems can suggest that users find this type of interaction useful and it helps sales by guiding clients to the products they need. The researcher did not find any published studies by e-commerce companies to support these claims. However, there have been several academic studies on the use of faceted ESS that give evidence of its benefits as a style of search interaction. The studies and prototypes are described below.

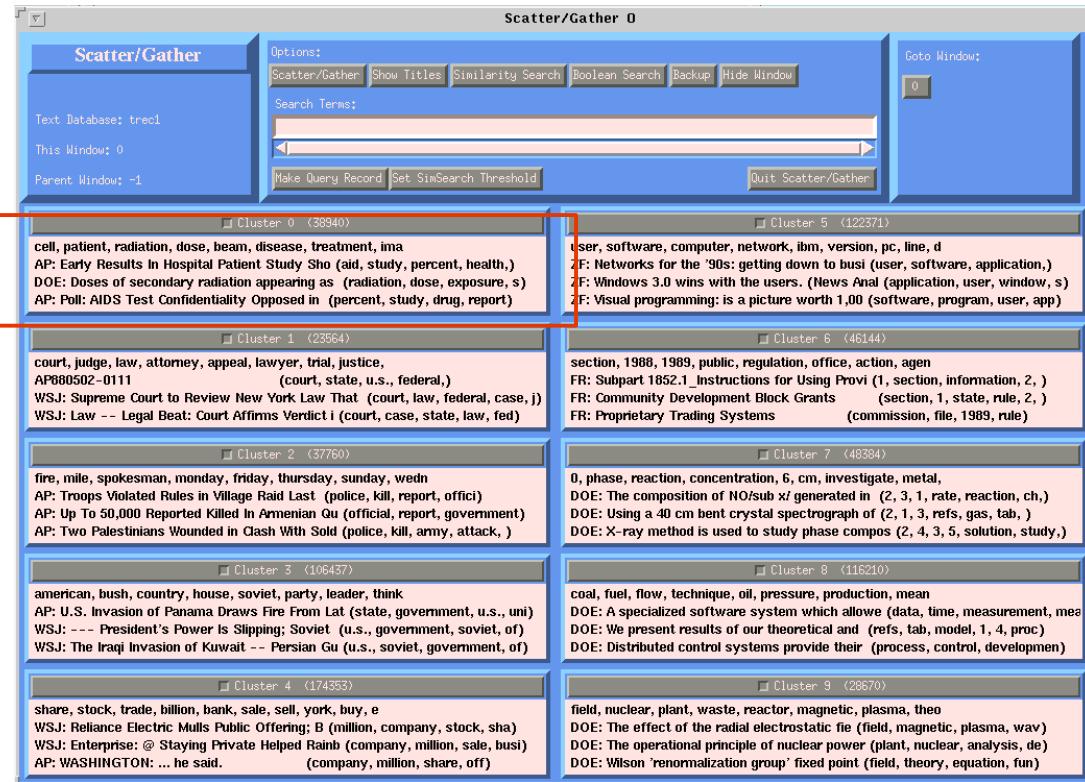
##### Scatter/Gather system

The Scatter/Gather system, developed by Pirolli, Schank, Hearst, & Diehl (1996) was designed to help users understand an information space better. The interface provides summaries of the available documents, which are placed in “clusters” (Fig 2.12). By navigating these clusters, users can get a better perception of the “topic structure” of large collections. The study tested the prediction that the system would stimulate learning in users and that they would be more aware of the information structure. The authors expected Scatter/Gather to give participants a better idea of how relevant documents are distributed.

Pirolli and colleagues analyzed saved documents and their relevance. Results from the study showed that participants using Scatter/Gather were not as successful in retrieving specific documents (Pirolli, Schank, Hearst, & Diehl, 1996). However, findings showed that participants using this system increased their use of new query search terms and produced topics/terms that were not part of the topic description. This supports the hypothesis by

Pirolli, Schank, Hearst, & Diehl (1996) that Scatter/Gather increases the user's topic awareness and "topic language" (Pirolli, Schank, Hearst, & Diehl, 1996). When participants were asked to draw diagrams of the topics, Scatter/Gather diagrams were very broad. By examining the content of the same diagrams, the researchers observed the introduction of more new terms and topics when participants were using Scatter/Gather. These phenomena can lead one to believe that participants have learned more about the subject matter using Scatter/Gather.

Facets and a faceted navigation are based on the same principle: data are organized in "categories" and are highly browse-able. The results of the above study indicate that the use of faceted navigation improves topic understanding and information distribution mental model. The study also shows that these types of navigation systems are not ideal for "known item" searches, for example, a specific product or a specific article. However, one can conclude that if an interface implements both facets/clusters and a search box, it can prove highly successful for both quick retrieval and understanding of the data.



**Figure 2.12.** Scatter/Gather Interface. Adapted from " Scatter/gather browsing communicates the topic structure of a very large text collection," by P. Pirolli, P. Schank, M. Hearst and C. Diehl, 1996, InProceedings of the SIGCHI conference on Human factors in computing systems: common ground, 213–220.

### The Flamenco Project

The solution of combining a search box with facets is implemented in later studies such as the one by English, Hearst, Sinha, Swearingen, & Lee (2002) aimed at comparing faceted search to a more conventional single-hierarchy search system. Towards that end, a faceted (“Matrix View”) interface and a single-hierarchy (“SingleTree View”) interface were developed and tested with users. Both allowed users to search for images from a large architectural database.

In the study, the faceted interface consisted of a left panel with facets, a search box,

and search results displayed in the center (Fig 2.13) (English, Hearst, Sinha, Swearingen, & Lee, 2002). The user could select multiple items from the facets in any order. In the “SingleTree View”, the results were displayed in a simple hierarchy (Fig 2.14). Only one category could be selected at a time. Both interfaces showed search filters as breadcrumbs but “Matrix View” allowed multiple filters to be selected.

Both interfaces were tested with architecture students (English, Hearst, Sinha, Swearingen, & Lee, 2002). A majority of whom preferred the “Matrix View” interface over the “SingleTree View”. They found the “Matrix View” easier and more flexible for refining their searches. The system was also seen as better for exploring and browsing the collection. In addition, post-survey results showed that participants felt more in control when using it.

In another study of the same “Matrix View”, the interface was compared to a prototype “Baseline” that represented the most common features of the most popular image search engines at the time of that study (Yee, Swearingen, Li, & Hearst, 2003). The “Baseline” prototype delivered results in multiple pages, where each page showed the images in a table format. The user had the ability to go to the next page and input a new search query in a search box above the results.

The results from the study showed that users were more successful at retrieving task related images using the faceted “Matrix View” interface (Yee, Swearingen, Li, & Hearst, 2003). In the post-study questionnaire, participants rated the faceted system higher than the “Baseline” prototype. The “Matrix View” was considered “easy to use” and “easy to browse”. Subjects also pointed out that the faceted search helped them become more familiar with the collection. Some participant comments confirm that faceted navigation can serve as

a guide to the user by “prompting” them where to go next”.

**Matrix View**

Refine your results further within these categories:

- Locations** > South America X
- [start over](#)

**People (group)**  
architect (157), culture (79)

**Locations: all > South America**  
Argentina (2), Bolivia (119),  
Brazil (191), Colombia (26),  
Peru (297), Venezuela (14)

**Structure Types (group)**  
architectural elements (150),  
buildings (by function) (334),  
buildings (by location or context) (29), buildings (by massing or shape) (21), cultural landscapes (12), details (66), human settlements (by condition) (101), human settlements (by form) (18), human settlements (miscellaneous) (7), landscaping (18), more...

**Materials (group)**  
brick (33), building materials (30), cement (2), ceramic tile (5), chemical compounds (11), clay (2), coating (14), concrete (60), glass (7), metal (4), more...

**Periods (group)**  
17 & 18th C (22), 19th Century (8),  
20th Century (169), Modern (63)

**Styles (group)**  
Early Mediterranean (7).

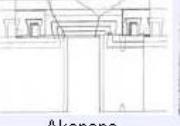
Search  all items  within current results

654 items (grouped by locations) [view ungrouped items](#)

**Argentina 2**

	
San Ignacio Mona... San Ignacio Monastery no architect	no name Buenos Aires no architect

**Bolivia 119**

			
Akapana Tiahuanaco no architect	Akapana Tiahuanaco no architect	Akapana Tiahuanaco no architect	Akapana Tiahuanaco no architect
<a href="#">all 119 items...</a>			

**Brazil 191**


--

**Figure 2.13.** Matrix View. Adapted from “Flexible search and navigation using faceted metadata” by J. English, M. Hearst, R. Sinha, K. Swearingen, and K. Lee, 2002, Technical report, University of Berkeley, School of Information Management and Systems.

The screenshot shows a Microsoft Internet Explorer window titled "NewSingleTree Interface - Microsoft Internet Explorer". The main title bar says "Tree View". Below it, the URL bar shows "Home > Locations > South America". On the right side of the title bar, there are three small thumbnail images. The top right corner has a "start over" link.

Below the title bar, there is a search bar with a "Search" button and two radio buttons: one for "all items" and one for "within current results".

A red box highlights the "Categories" section. It lists "Argentina 2", "Bolivia 119", and "Brazil 191" under the heading "Categories". To the right, another red box highlights "Colombia 25", "Peru 297", and "Venezuela 14".

Below these sections, a message says "Items 1 - 50 of 654 results (ungrouped, sorted by building name)". To the right, there are links for "group by locations" and "sort by: location, architect".

A horizontal navigation bar shows page numbers from 1 to 654, with "1" highlighted in purple and "501" through "654" in grey. A "...651654" ellipsis is also present.

The main content area displays a grid of 15 items, each with a thumbnail image, the name, and the architect. The items are:

- Akapaná Tiahuanaco no architect (repeated 5 times)
- Altos de los Ido... San Agustín no architect (repeated 2 times)
- Altos de los Ido... Altos de los Idoles no architect (highlighted with a red box)
- Alvorada Palace Brasilia Niemeyer, Oscar (repeated 2 times)
- Alvorada Palace Brasilia Niemeyer, Oscar (highlighted with a red box)
- Alvorada Palace Brasilia Niemeyer, Oscar (highlighted with a red box)

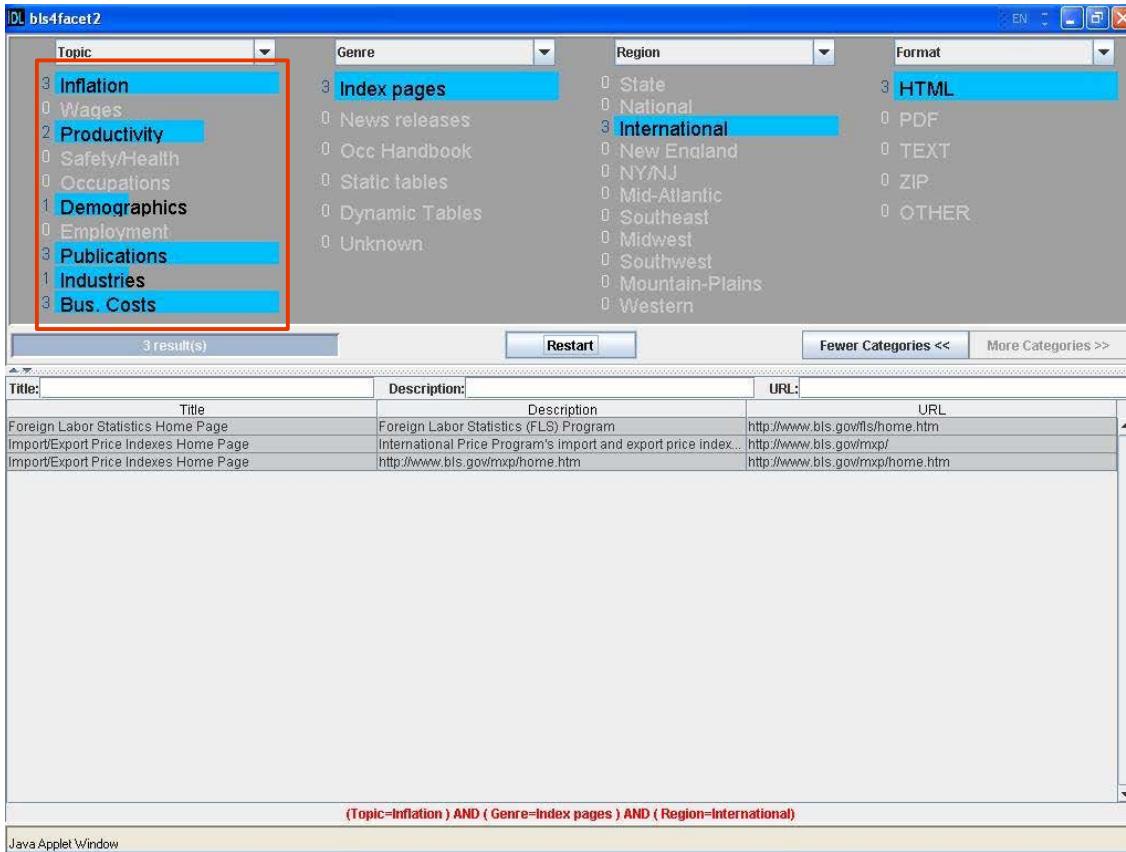
**Figure 2.14.** Tree View. Adapted from “Flexible search and navigation using faceted metadata” by J. English, M. Hearst, R. Sinha, K. Swearingen, and K. Lee, 2002, Technical report, University of Berkeley, School of Information Management and Systems.

### The Relational Browser

Another important study by Capra, Marchionini, & Oh (2007) examines how facets and their visual presentation affects search results. Participants interacted with three different search interfaces: a “standard website homepage”, a “simple faceted” interface with “no graphical embellishments”, and a “highly interactive” interface with identical facet structure

named Relation Browser (Fig 2.15). The design of the Relation Browser interface places a significant visual emphasis on what has been selected by displaying a blue bar across the selection. In addition, the length of the blue bar denotes the amount of resources available for that facet option. This is a good example of implementing the principle of visual representation of available data for an ESS (White & Roth, 2009).

Participants in the study responded positively to the Relational Browser's narrowing/filtering abilities, as well as its visual presentation of the data and how it is related. One comment from the study exemplified that, "(I liked) The relation system because I was able to narrow down my search much more quickly and able to find exactly what I was looking for." (Capra, Marchionini, & Oh, 2007) Another comment from the same study spoke of a participant's better understanding of the subject area, "The relational [interface] showed me how many results were present for a certain topic, and then their relationship to other topics." (Capra, Marchionini, & Oh, 2007)



**Figure 2.15.** Relational Browser Interface. Adapted from “Effects of structure and interaction style on distinct search tasks” by R. Capra, G. Marchionini, and J. Oh, 2007, InProceedings of the 7th ACM/IEEE-CS joint conference on Digital libraries, 442–451

## SERVICE

In another interesting study, Kules & Shneiderman (2008) explored how facets impact understanding and how they can be visually paired with results to help the exploratory search process. The researchers developed SERVICE (Search Result Visualization and Interactive Categorized Exploration): two prototypes of a search interface for finding news articles. The first version was a “baseline” search engine, similar to Google. The second was a categorized overview type of interface, which used the standard facet search layout with

facets in the left panel and results in the right (Fig 2.16). When the user clicked on a facet option/item, the results narrowed. When he/she hovered the mouse over a result item the system highlighted all categories that contained that item (Fig 2.17), thus supporting the principle of “tight coupling” (Kules & Shneiderman, 2008) between faceted navigation and results. This principle helps the user establish visual connection between facets and results and thus helping him/her make better search choices.

The screenshot shows a Mozilla Firefox browser window with the title "median - Categorized Search - Mozilla Firefox". The address bar contains the URL <http://localhost:8080/Service2/src/WebSearch25.jsp?q=median&c=100&uid=unknown&el=>. The search query "median" is entered in the search bar. The interface includes a sidebar with facet categories and their counts:

- Topic Category**
  - Science (24)
  - Reference (19)
  - Arts (7)
  - Kids and Teens (6)
  - Society (6)
  - Business (6)
  - Computers (5)
  - Health (4)
  - Home (3)
  - News (3)
  - Sports (1)
- Geography**
  - North America (18)
  - Europe (2)
  - Oceania (1)
- Last Visited**
  - Before Last Week (6)
  - Never Visited (94)

The main content area displays search results for "median" under a heading "Top 100 results containing median". The results are organized into sections:

- Median**: A definition of median as the middle of a distribution, comparing it to the mean and mode.
- Mean and Median**: A link to a page on Rice University's website explaining the concepts.
- Median**: Another definition, emphasizing its ease of determination compared to the mean.
- Introduction to Statistics: Mean, Median, and Mode**: A link to a lesson from Shodor.org.
- Mean, Median and Mode Discussion**: A student discussion thread from Shodor.org.
- CancerGuide: The Median Isn't the Message**: An essay by Gould about cancer statistics.
- Median - Wikipedia, the free encyclopedia**: A brief summary from Wikipedia.
- BBC - KS2 ReviseWise - Maths: Data Handling**: A link to a BBC educational resource.

**Figure 2.16.** SERVICE Faceted Interface. Adapted from “Users can change their web search tactics: Design guidelines for categorized overviews.” by B. Kules, and B. Shneiderman, 2008, Information Processing & Management, 44(2), 463–484.

The screenshot shows a Mozilla Firefox browser window with the title "median - Categorized Search - Mozilla Firefox". The URL in the address bar is <http://localhost:8080/Service2/src/WebSearch25.jsp?q=median&c=100&uid=unknown&el=>. The search query "median" is entered in the search bar. The results are displayed in a categorized overview:

- Topic Category** (highlighted in green):
  - Science (24)
  - Reference (19)
  - Arts (7)
  - Kids and Teens (6)
  - Society (6)
  - Business (6)
  - Computers (5)
  - Health (4)
  - Home (3)
  - News (3)
  - Sports (1)
- Geography** (highlighted in green):
  - North America (18)
  - Europe (2)
  - Oceania (1)
- Last Visited** (highlighted in green):
  - Before Last Week (6)
  - Never Visited (94)

**Top 100 results containing median**

**Median**  
The **median** is the middle of a distribution: half the scores are above the ... The **median** is less sensitive to extreme scores than the mean and this makes it ...  
[davidmlane.com/hyperstat/A27533.html](http://davidmlane.com/hyperstat/A27533.html)

**Mean and Median**  
[www.ruf.rice.edu/~lane/stat\\_sim/descriptive/](http://www.ruf.rice.edu/~lane/stat_sim/descriptive/)

**Median**  
Again, this statistic is easy to determine because the **median** literally is ... Comparing the mean to the **median** for a set of data can give you an idea how ...  
[www.robertniles.com/stats/median.shtml](http://www.robertniles.com/stats/median.shtml)

**Introduction to Statistics: Mean, Median, and Mode**  
The goal of this lesson is to introduce the concepts of mean, **median** and mode ... The Mean and **Median** Activity lets students explore mean and **median** in an ...  
[www.shodor.org/interactivate/lessons/sm1.html](http://www.shodor.org/interactivate/lessons/sm1.html)

**Mean, Median and Mode Discussion**  
Student: When do we use mean and when do we use **median**? ... Unfortunately, too often people call mean, **median** and mode by the same name: average. ...  
[www.shodor.org/interactivate/discussions/sm1.html](http://www.shodor.org/interactivate/discussions/sm1.html)

**CancerGuide: The Median Isn't the Message**  
The text of an essay by Gould on the subject of cancer and statistics, based on his affliction with--and subsequent recovery from--a rare form of cancer, ...  
[www.cancerguide.org/median\\_not\\_msg.html](http://www.cancerguide.org/median_not_msg.html)

**Median - Wikipedia, the free encyclopedia**  
To find the **median** of a finite list of numbers, arrange all the ... But the **median** amount is \$5, since one may divide the group into two groups of 10 ...  
[en.wikipedia.org/wiki/Median](http://en.wikipedia.org/wiki/Median)

**BBC - KS2 ReviseWise - Maths: Data Handling**  
An animated I/C/T DevelopMentor activity for the maths topic mode, median, mean, ...  
[www.bbc.co.uk/ks2/bitesize/maths/HandlingData/activity/mean\\_median\\_mode/default.shtm](http://www.bbc.co.uk/ks2/bitesize/maths/HandlingData/activity/mean_median_mode/default.shtm)

**Figure 2.17.** SERVICE Faceted Interface, highlighting selections. Adapted from “Users can change their web search tactics: Design guidelines for categorized overviews.” by B. Kules, and B. Shneiderman, 2008, Information Processing & Management, 44(2), 463–484.

Most participants found the category overview (facets) beneficial for their searches due to its ability to narrow and preview the results. Subjects found the “stability” of the categories very reliable, which resonates with Tunkelang’s (2009) guideline of keeping the facet order static. Testers also considered the faceted interface more appealing.

Results from the study show that participants using the faceted (overview) interface

explored more deeply into the results. However, Kules & Shneiderman (2008) express a concern that by using one category and narrowing down the results, users might be omitting information. They claim that this could contribute to the problem of obtaining a narrow view of a topic.

### Gaze Behavior

Most of the previously listed studies relied on user feedback to gain understanding of how participants interacted with the systems. Kules & Capra (2012) used eye tracking to trace what subjects attended to and how they used the different elements of an interface. The researchers used North Carolina State University's faceted library catalog to analyze the patterns of eye movement. The eye tracking software allowed them to trace the path of participants' eyes as they moved from one element on the screen to another.

The NCSU system used for the study was a standard faceted search interface in that it provided a faceted navigation in a left panel and displayed the results from the search in the center. The interface also included a text (keyword) search at the top (Fig 2.18). Three facets were used in the faceted navigation: "Subject", "Region", "Time period". Each facet item displayed in parentheses the number of resources fitting that facet category, thus giving a visual representation of the available resources, which is recommended by White & Roth (2009). Breadcrumb interaction was also available above the search results section and current filters could be removed by clicking the "X" button.

The screenshot shows a library catalog search interface. At the top, there is a search bar with 'lincoln' entered, a dropdown menu set to 'Anywhere', and a 'Search' button. To the right of the search bar are links for 'Help' and 'My Bookbag'. Below the search bar is a 'Query' section with the text 'lincoln > Great Britain'. A 'Breadcrumb' trail follows: 'lincoln' > 'Great Britain'. On the left, a 'Refine Your Search' sidebar is visible with sections for 'Subject Facets', 'Region', and 'Time Period'. The 'Subject Facets' section includes categories like 'History (146)', 'Politics and government (36)', 'England and Wales (22)', 'Charles (15)', 'Law (9)', and 'Show more'. The 'Region' section includes 'England (50)', 'United States (16)', 'Lincoln (England) (11)', 'Lincolnshire (England) (10)', 'London (England) (7)', and 'Show more'. The 'Time Period' section includes 'Civil War, 1642-1649 (63)', '17th century (20)', 'Charles I, 1625-1649 (17)', '1642-1649 (13)', 'Charles II, 1660-1685 (10)', and 'Show more'. The main area is titled 'Results' and shows 1 of 252 items. The results are listed in a table with columns for the title, author, format, and an 'Add to Bookbag' button. The titles include: 'Lincoln's man in Liverpool : Consul Dudley and the legal battle to stop Confederate warships', 'Abraham Lincoln and a new birth of freedom : the Union and slavery in the diplomacy of the Civil War', 'Canon law and English common law : Selden Society lecture delivered in the Old Hall of Lincoln's Inn, July 5th, 1982', 'Legal records and the historian : papers presented to the Cambridge Legal History Conference, 7-10 July 1975, and in Li...', 'Town government in the sixteenth century, based chiefly on the records of the following provincial towns: Cambridge, Ch...', 'The fathers, the reformers, and the public formularies, of the Church of England, in harmony with Calvin, and against t...', and 'Further advice to the clergy of the diocese of Lincoln, [electronic resource]'. The results are sorted by relevance.

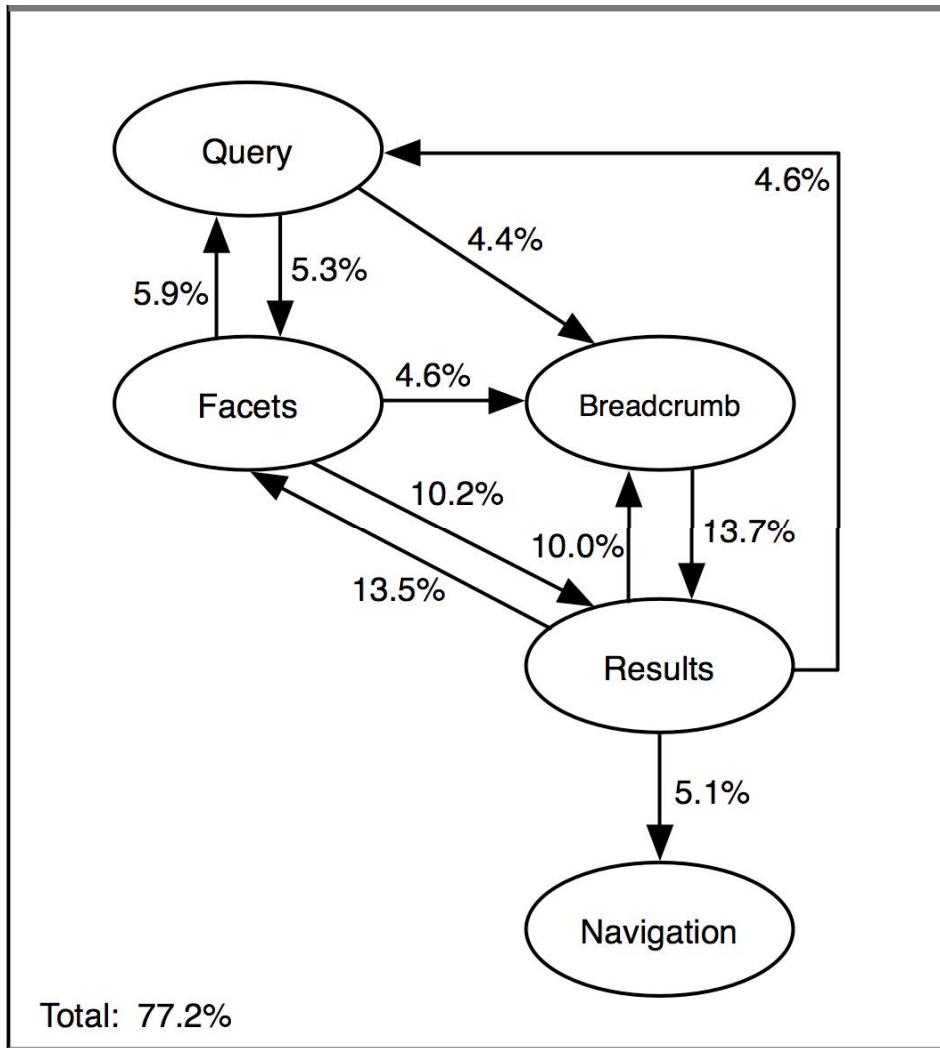
**Figure 2.18.** North Carolina State University faceted library search. Adapted from “Influence of training and stage of search on gaze behavior in a library catalog faceted search interface” by B. Kules and R. Capra, 2012, Journal of the American Society for Information Science and Technology, 63(1), 114–138.

Results from the study showed that gaze fixations occurred mostly over the results section. Facets came in second place, ahead of the breadcrumbs and the search box. In the tested interface layout the results section had most prominence due to its central location and size, which can explain why participants exhibited more fixations over that area. (Tunkelang, 2009). The study discovered that facets were sometimes observed but not clicked. This is an important finding because it shows that on occasions searchers might use facets as an

informing tool rather than actual navigation.

The results showed that almost half of all gaze transitions (47.4%) happened between the Facet-Results pair and the Results-Breadcrumb pair (Fig 2.19) (Kules, Capra, Banta, & Sierra, 2009). In Fig 2.19 one can see the different sections of the interface represented with ovals. The arrows show the percentage of gaze transitions to and from each of the sections. The diagram depicts only the top ten transition pairs. In general, the facets were involved in more than a third of all transitions (Kules, Capra, Banta, & Sierra, 2009). The study shows that facets are referred to often and serve as a constant guidance. This is also why the principle of “tight coupling” between navigation and results is essential for the success of the ESS as described earlier on page 17.

Significant involvement of the facets in the search process is confirmed by subjects' comments in the post interview. One participant noted that she paid attention to the facets when she did not understand the subject matter and the listed results very well. Some participants showed exploratory behavior when they were clicking on the facets to see what was available in the collection without worrying about the results. One of the participants described this behavior as “shopping around”.



**Figure 2.19.** Top 10 gaze transitions between AOIs across all participants, task scenarios, and page views. Adapted from “What do exploratory searchers look at in a faceted search interface?” by B. Kules, R. Capra, M. Banta, and T. Sierra, 2009, Proceedings of the 2009 joint international conference on Digital libraries - JCDL ’09, 313.

### 2.6.5 Faceted ESS Studies Summary

The listed studies above indicate several benefits of a faceted ESS. Users showed increase in learning and understanding of the topic. They were able to refine their results much easier through the narrowing and filtering capabilities of the facets. Users also explored

the data more deeply and became more familiar with the data collection. The facets were referred to often and were used as guidance: participants used them to understand the topic and to “shop around” for results. Subjects also enjoyed more visual representation of the data through colored bars.

### **2.6.6 Faceted ESS Limitations**

Traditional faceted navigation styles allow one to drill down into a subject matter to find very specific documents. One limitation to this, however, is the possibility to obtain a very “narrow” view of the issue, which is recognized in Kules and Shneiderman's study (Kules & Shneiderman, 2008).

Dynamic search queries, on the other hand, can give users the opportunity to quickly analyze results from many categories and also view intersecting results by selecting multiple categories at the same time, thus obtaining a much broader view of an issue. They can also contribute to a better “tight coupling” of results with navigation which is not so strong with some of the interfaces discussed above. A dynamic faceted navigation shows these connections immediately.

Furthermore, a dynamic queries search does not interrupt the interaction between the user and the system. The state of the interface is constant: it does not change or reload when new data is requested, except for the section that needs update (e.g. results section). This is not the case with most current web-based faceted search systems. They rely on the traditional approach where data is obtained from the server by loading a new page that responds to the query parameters. Depending on the speed of the server and the user's Internet connection, the process can take anywhere from less than a second to ten or more seconds, including the

time to reload all of the necessary code to run the page (HTML, CSS, JavaScript). This not only slows the user down, but also creates an unwanted pause and the searcher may need to recapture the location of all interface elements. As it was shown earlier, such data retrieval interaction can also disorient users by sending them back to the very top of the page.

## 2.7 Dynamic Queries

Shneiderman (1994) identifies dynamic queries interfaces as systems that provide widgets to search the data collection and allow the user to iterate through tens of queries in seconds. The results are displayed rapidly with transition animations to inform the user of what changes have occurred after they have manipulated the controls. Shneiderman indicates that when users work with a system that supports dynamic queries, they can feel more in control and obtain a better understanding of the information structure. The researcher also proposes that by “flying through” the data when moving sliders and using other widgets, users can start to recognize patterns and gaps in the data to form a hypothesis or discover the starting point for new research (Shneiderman, 1994). This could have great positive impact on academic searchers who are in the exploratory phases of their research.

Using widgets like sliders to query a collection is a type of direct manipulation which creates a much easier way to input information than actually typing it in a field (Ahlberg, Williamson, & Shneiderman, 1992). Direct manipulation is characterized by pointing and selecting interface elements, and receiving immediate feedback (Shneiderman, 1993). In a dynamic queries interface the user needs to conduct a physical action to change the value, for example, to drag the slider's handle with the mouse. This interaction, paired with immediate results, can produce numerous queries and shows how the data are changing when the

widgets are manipulated. It also makes the process more fun when users start to play around with the controls. This is particularly evident from user comments in the study of the Periodic Table interface on page 46. Direct manipulation controls also prevent invalid entry errors (e.g. incorrect date format), which can occur within systems that use text input fields.

Dörk, Carpendale, Collins, & Williamson (2008) demonstrate that visual querying may ease the search process especially when dealing with concepts and terms that are hard to express through words. One example that the researchers give is expressing time range through words: “during February or March last year” or “last summer”. A simple date slider or other type of widget can solve this problem. Another positive aspect of dynamic queries, according to the researchers, is that they facilitate the “casual formulation of complex queries”. By using widgets and other visual means, the system can relieve the users from devising textual ways to query the information collection.

### **2.7.1 Dynamic Queries Guidelines**

Ahlberg, Williamson, & Shneiderman (1992) indicate several key factors for a more desirable search interface. They point out that it needs to “represent the query graphically”. A control needs to indicate the range of the queried data. The use of sliders shows that range by indicating the maximum and minimum values. The researchers also point out that the system needs to provide “immediate feedback of the result” after use of a widget (Ahlberg, Williamson, & Shneiderman, 1992; Dörk, Carpendale, Collins, & Williamson, 2008). Element highlighting or search result animations can contribute to the user understanding of how the data set is organized (Dörk, Carpendale, Collins, & Williamson, 2008).

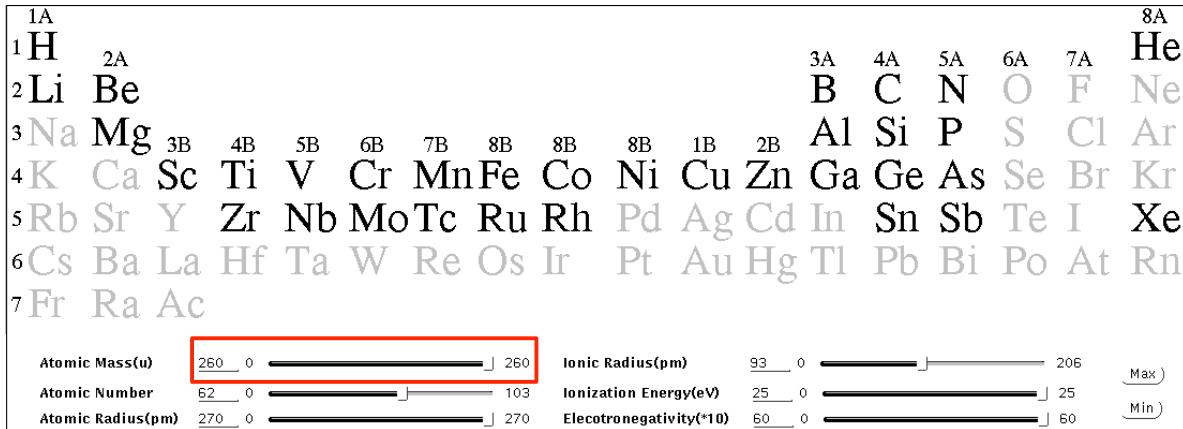
Williamson & Shneiderman (1992) emphasize the importance of appropriate visual

presentation of dynamic queries layouts. Sliders and other widgets need to be placed in close proximity to the results section to reduce eye movement. In addition, the designer needs to consider proper color use for highlighting elements and showing selections (Dörk, Carpendale, Collins, & Williamson, 2008; Williamson & Shneiderman, 1992). In HomeFinder (see page 47) the same color is used to show highlighted homes and the slider range selection (Williamson & Shneiderman, 1992). This informs the user visually that the two elements are connected and one represents the other.

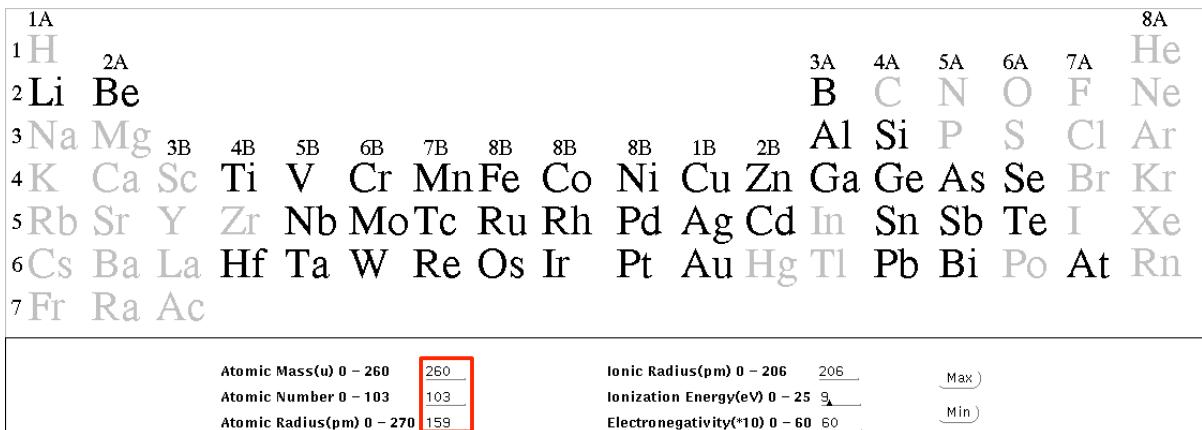
### **2.7.2 Dynamic Queries Examples and Studies**

#### Periodic Table

Ahlberg, Williamson, & Shneiderman (1992) conducted a user study of three systems for querying the periodic table of elements. The first interface used dynamic queries with sliders to input all the element properties. Elements that corresponded to the set parameters were immediately highlighted (Fig 2.20). The system supported all of the previously described guidelines by representing the query graphically through sliders showing the range of data input and showing the results immediately by highlighting the corresponding elements. The second interface represented the results in the same way but parameters had to be input through text fields (Fig 2.21). The last tested interface was textual for both the input and the output of the query.



**Figure 2.20.** Dynamic Queries Periodic Table prototype. Adapted from “Dynamic queries for information exploration: An implementation and evaluation.” by C. Ahlberg, C. Williamson, and B. Shneiderman, 1992, In Proceedings of the SIGCHI conference on Human factors in computing systems, 619–626.



**Figure 2.21.** Text Input Periodic Table prototype. Adapted from “Dynamic queries for information exploration: An implementation and evaluation.” by C. Ahlberg, C. Williamson, and B. Shneiderman, 1992, In Proceedings of the SIGCHI conference on Human factors in computing systems, 619–626.

Participants using the dynamic queries interface showed faster times for completing a query. In addition, the number of user errors was much smaller compared to the other prototypes. Participants expressed high levels of satisfaction and enjoyment when using the dynamic queries: “The sliders are more fun than the key punch”, “You can play around more without worrying about messing it up” (Ahlberg, Williamson, & Shneiderman, 1992). This type of playfulness has the possibility to be extremely valuable for a serious endeavor such as academic research. Academic research can be overwhelming and even frightening for some, especially novice researchers. By bringing in more joy from the search process, it can be turned into a less daunting task.

### HomeFinder

Williamson & Shneiderman (1992) conducted a study of the HomeFinder interface to assess its use of dynamic queries. HomeFinder used a combination of sliders and toggle buttons. It could be used by a person who is looking for a new residence, be that a house or an apartment. The sliders could be used to specify distances, number of bedrooms, and price, while the buttons were used for checking a category or an option on or off (Fig 2.22). As the user moved the controls, the residence locations changed to correspond to the query parameters. All of these actions were immediately followed by results change. Here again the query was represented graphically, it shows the range of data input within the widget, and data changes are displayed immediately.

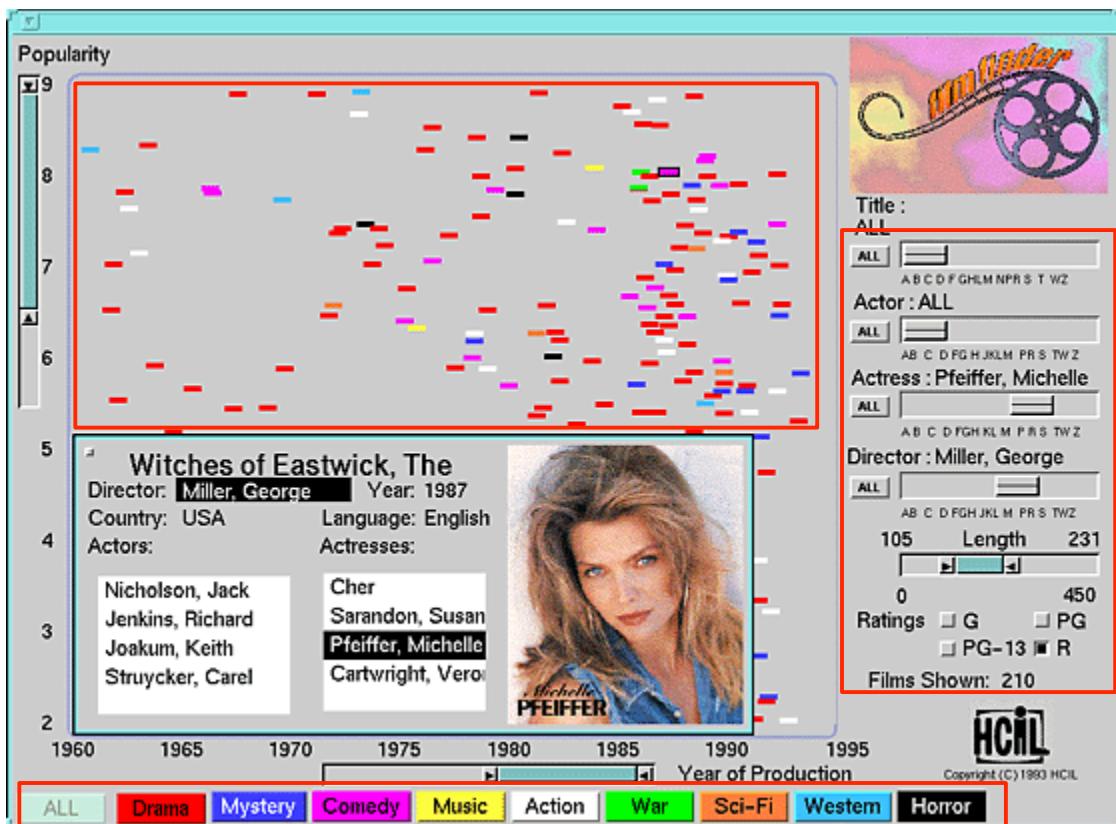


Figure 2.22. HomeFinder. Adapted from “The Dynamic HomeFinder: Evaluating dynamic queries in a real-estate information exploration system” by C. Williamson and B. Shneiderman, 1992, Proceedings of the 15th annual international ACM SIGIR conference on Research and development in information retrieval, 338-346.

The study compared the dynamic system to an interface that used textual input, and a page listing of the same data (Williamson & Shneiderman, 1992). Results from the study showed that, except for task one, participants using HomeFinder performed with the fastest times. Subjects scored high especially for the more complex search tasks, where the user had to meet several criteria and identify trends. This confirms the Shneiderman (1994) theory that dynamic search can facilitate users in recognizing trends and getting a better view of the information space. In addition, the dynamic queries interface scored higher in the satisfaction ratings. Participants expressed their delight in using it and were very enthusiastic about it, “I don’t want to stop, this is fun!” (Williamson & Shneiderman, 1992)

## FilmFinder

Shneiderman & Ahlberg (1994) developed the FilmFinder, a system that allows users to use dynamic queries to search a film database. The interface of FilmFinder contains sliders and other widgets for querying, and a “starfield” representation of the data results. The results view represents information in a graph (scatter plot) format, where a point visually represents each film, and each point has a color based on a film category (Fig 2.23). The scatter plot uses release time and popularity as axes. More popular movies that were created recently would be shown in the upper right corner of the graph display. This visual approach of displaying information can help users gain a rapid overview of available movies data and how those data are structured. This concept is also supported by White & Roth (2009) in their ESS guidelines to represent results more visually.



**Figure 2.23.** FilmFinder. Adapted from “Visual Information Seeking using the FilmFinder” by B. Schneiderman and C. Ahlberg, 1994, In Conference companion on Human factors in computing systems, 433-434.

### VisGets

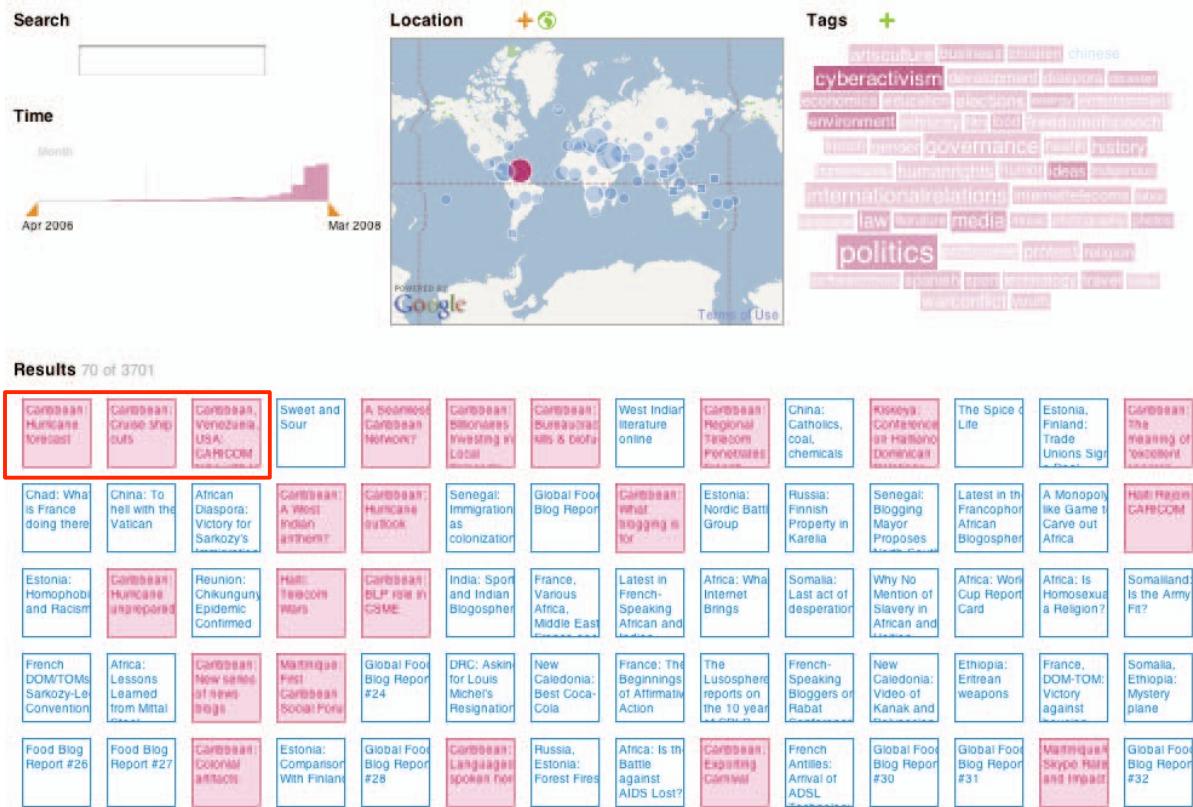
Dörk, Carpendale, Collins, & Williamson (2008) created VisGets, a system that gives the user ability to visually query web resources through dynamic search tools. The system explores the data through “weighted brushing”, “delta queries”, and map visualizations. The time dimension, or as researchers call it “temporal dimension”, uses interactive charts that represent the amount of resources per date. Sliders at the bottom allow for change in the range. The location dimension is represented by a map with square and circle markers at different scale used to indicate location and amount of resources. The user can change the

query by zooming in and out of the map. This action confines the result set to only the visible markers of the map. The system also features a tag cloud widget representing topical overview of the information collection, which can be used to filter the result set to only items that contain the selected tag (Fig 2.24).



**Figure 2.24.** VisGets: time dimension, location dimension, and tag cloud. Adapted from “VisGets: coordinated visualizations for web-based information exploration and discovery” by M. Dörk, S. Carpendale, C. Collins, and C. Williamson, 2008, IEEE transactions on visualization and computer graphics, 14(6), 1205–12.

After manipulation of any widget, the search results section displays related items and removes unrelated ones through the use of animated transitions. The system also provides a “weighted brushing” feature, which allows the user to see related results and dimensions. When the user hovers over a dimension, all related dimensions and result items are highlighted, while unrelated are dimmed down (Fig 2.25). This method implements the principle of “tight coupling” discussed earlier (Kules & Shneiderman, 2008).



**Figure 2.25.** VisGets results. Adapted from “VisGets: coordinated visualizations for web-based information exploration and discovery” by M. Dörk, S. Carpendale, C. Collins, and C. Williamson, 2008, IEEE transactions on visualization and computer graphics, 14(6), 1205–12.

When the interface was tested, the results showed that participants responded favorably of the system. Subjects noted the “temporal dimension” to be particularly helpful. Researchers believed that the “temporal dimension” was favored because of how difficult it could be to express time range with words and find results.

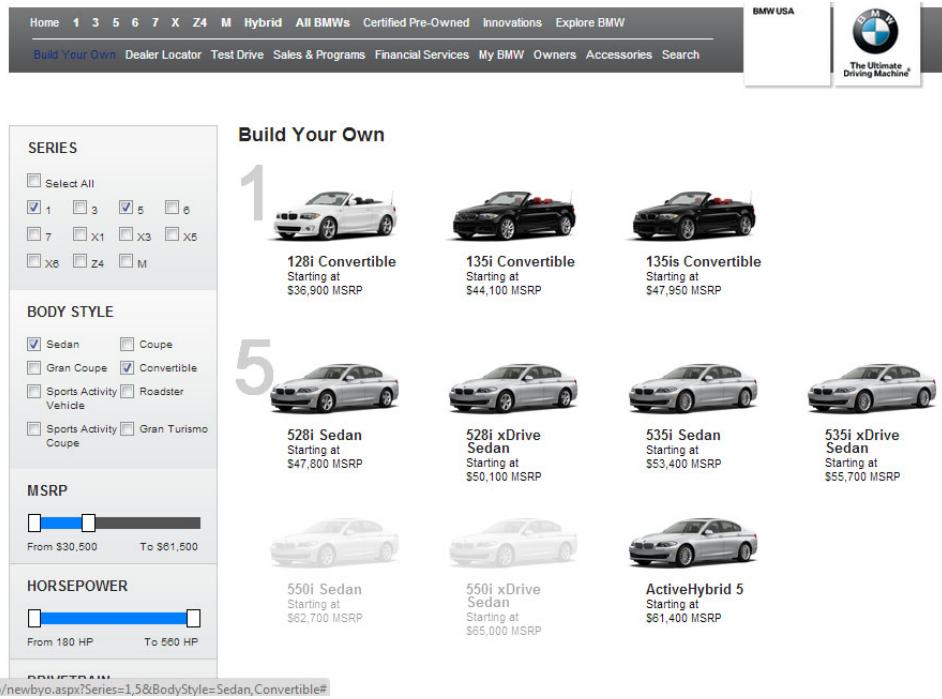
### BMW Build Your Own

Use of dynamic queries has found a place in several e-commerce websites and services that have search functionality. One such example is the BMW Build Your Own

page. It offers a visual search of car models.

The interface presents a dynamic faceted navigation which uses the following product metadata: “Series”, “Body style”, “MSRP”, “Horse Power”, etc. Each of these is represented with an appropriate user interface control: value specific check boxes for “Series” and “Body style”, range value sliders for “MSRP” and “Horse Power”. The results are shown in the center section of the interface. As the user checks facet options on and off, or moves the slider handles, the resulting models change in real time using an attractive animation (Fig 2.26).

This interface takes out the rigidity of researching different models by giving the user the tools to find what fits his/her exact needs, while still having fun doing it. There is no publicly available user testing data for this system that proves its effectiveness. However one can see its potential because the interface meets the criteria mentioned by Williamson & Shneiderman (1992) and Ahlberg, Williamson, & Shneiderman (1992): it represents the data graphically with animated transitions to show how the data change; the slider controls and check boxes show data ranges and available options; there is immediate feedback after every query adjustment.



**Figure 2.26.** BMW “Build Your Own” screen after several controls were manipulated

### 2.7.3 Dynamic Queries Summary

As the studies and the described prototypes show above, a dynamic queries interface is often a combination of toggle buttons/checkboxes and slider widgets. Search results are produced immediately when the user manipulates the controls. The instant delivery of results and the ability to quickly iterate through tens of queries can help recognize gaps and trends in the information collection. Results from the studies showed that generally users took less time to complete their search tasks using a dynamic queries interface. They also experienced higher levels of satisfaction with the search process, describing it as “fun”.

### 2.7.4 Dynamic Queries Limitations

The implementation of dynamic queries is limited primarily by the software and

hardware used for the search system and its users. Williamson & Shneiderman (1992) expressed concerns mainly about the screen real estate availability to support this search technique. However, their studies were conducted in the early nineties when screen resolutions were very small. Today we enjoy resolutions several times higher that allow for more complex interfaces.

Williamson & Shneiderman (1992) also addressed the requirement for custom programming when developing dynamic queries interfaces. However, with recent innovations in software and the advancement of AJAX (Asynchronous JavaScript and XML) for web applications, this type of interaction is becoming standard and easier to integrate.

AJAX is a widely used mix of web technologies that makes dynamic querying on the web possible. In the traditional approach to building web applications, there is always a delay to the user interaction because a new page needs to be loaded in the browser when the user performs some type of action with the data. The user is required to wait for the new page to load in order to continue. AJAX eliminates this problem by adding a layer between the user and the server, which performs communication in the background. This extra layer is an AJAX engine that “communicates with the server on the user's behalf” and makes any necessary changes to the interface without interrupting the user's interaction with the system (Garrett, 2005).

All of Google's major applications (Gmail, Google Maps) in use today take advantage of AJAX. As Garrett (2005) points out, these are real world examples that show AJAX as a trustworthy method, which can be used for very complicated operations. A dynamic queries application for the web can take advantage of this approach to deliver the user experience

envisioned by Shneiderman and colleagues.

### **2.7.5 Dynamic Queries for Academic Search**

Dynamic queries can be highly effective for search environments including scholarly search engines. Earlier in this chapter, it was established that faceted interfaces can stimulate users in their exploratory endeavors. The combination of that approach with dynamic querying methods has the potential to improve search results, as well as user satisfaction.

Dynamic queries allow the users to iterate through numerous searches with simple mouse actions. Consequently, this allows them to potentially gain a better understanding of a topic or research area, which is something essential for academic searches. In addition, users start to recognize trends in the data or missing research, which can be the seed of a new research topic. Dynamic queries also make the academic search process less stressful by adding a playful aspect to it.

## CHAPTER 3. METHODOLOGY

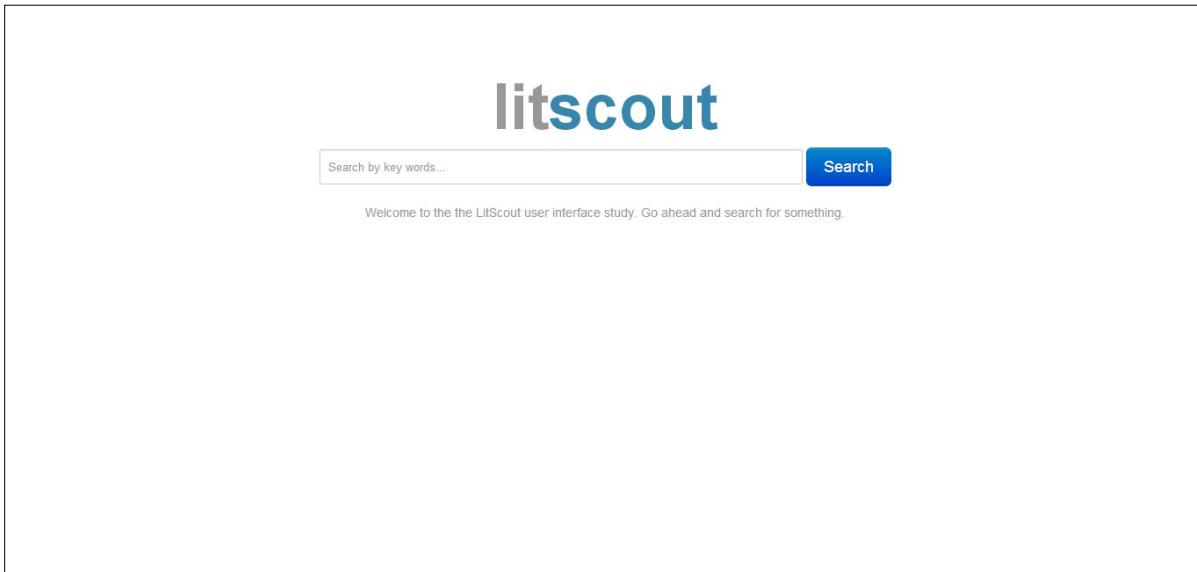
The objective of this research is to evaluate dynamic queries techniques when applied to a journal article/library search engine and assesses their usage for this type of searches. To achieve this, the researcher built and tested two prototypes: a regular faceted search and a dynamic queries search engines. The goal of the study was to compare and contrast the two types. In addition, the research examines the overall impact and usage of faceted navigation for scholarly searches. The results can be used to assist interaction designers analyze and improve upon academic search interfaces, as well as other more text-heavy search systems.

This chapter describes the process of designing and building the prototypes, recruiting and collecting participants' information, as well as user study procedures.

### 3.1 System Design

Two prototypes were developed for this study, both called LitScout (Fig 3.1). The two systems are almost virtually identical with differences only in the style of interaction when using the faceted navigation. The review pointed to a search interface design that combined keyword search with faceted browsing (Marchionini, 2006; White & Roth, 2009). This finding was adopted in the design process. The primary distinction between the two prototypes is in the nature of their faceted navigations. The dynamic queries interface (Interface 1) presents dynamic controls (Fig 3.2) that can be used to iterate through queries instantaneously, without waiting for the entire page to reload with new data, thus the interaction with the computer is uninterrupted. On the other hand, the regular facet interface (Interface 2) displays the facet options as links (Fig 3.3). The links force the traditional approach to retrieving new data by loading a new page into the browser. This puts a halt to the user interaction until the new page is loaded. The user is required to wait for the new

page to load in order to continue. The second prototype was designed to mimic the behavior of standard faceted searches that are already seen in use by libraries (Nagy, 2011).



**Figure 3.1.** Home screen for both interfaces. One call to action: keyword search.

**Figure 3.2.** Dynamic Queries interface. The facet options are represented by radio buttons, which update the results section dynamically.

The screenshot shows the Litscout search interface. On the left, there is a sidebar with a red border containing facet options: 'FIELD OF STUDY' (with links to 'Genetic Research', 'Mutation', 'Gene Mutation', 'Medical Research'), 'AUTHOR' (with links to 'Wang, Z', 'Lovett, Susan T', 'Heguy, Adriana', 'Lu, Charles'), 'COLLECTION' (with links to 'MEDLINE (NLM)', 'SciVerse ScienceDirect (Elsevier)', 'OneFile (GALE)', 'Health Reference Center Academic (Gale)'), 'RESOURCE TYPE' (with links to 'Articles', 'Newspaper articles', 'Reviews'), and a 'Next' button. The main search results area contains four entries:

- Association of age at diagnosis and genetic mutations in patients with neuroblastoma** by Cheung, Nai-kong V.; Zhang, Jinghui; Lu, Charles; Parker, Matthew; Bahrami, Armita; Tickoo, Satish K.; Heguy, Adriana; Pappo, Alberto S.; Federico, Sara; Dalton, James; Cheung, Irene Y.; Ding, Li; Fulton, Robert; Wang, Jianmin; Chen, Xiang; Becksfort, Jared; Wu, Jianrong; Billups, Catherine A.; Ellison, David; Mardis, Elaine R.; Wilson, Richard K.; Downing, James R.; Dyer, Michael A. (genetic)
- Teasing apart cancer's influences. (CANCER GENETICS) (Brief article)** by unknown author (Nature, Feb 10, 2011, Vol.470(7333), p.143(1))
- Alzheimer's in a dish. (CELL BIOLOGY) (Brief article)** by unknown author (Nature, August 11, 2011, Vol.476(7359), p.129(1))
- Genetic mutations and mechanisms in dilated cardiomyopathy** by McNally, Elizabeth M.; Golbus, Jessica R.; Puckelwartz, Megan J. (Genetic)

**Figure 3.3.** Regular Facet interface. The facet options are represented by links.

The design of the dynamic queries prototype went through a couple of revisions to reach a stage where it could be technically implemented and tested with study participants. Some of the features had to be changed or removed to work with the available data structures and back-end used for this study, which are discussed below. Nevertheless, it is important to describe the original design, in order to fully understand the goals and outcomes of the study.

### 3.1.1 Original design

The original design of the dynamic queries prototype aimed to follow Shneiderman, Williamson, and Ahlberg's design guidelines closely (Ahlberg, Williamson, & Shneiderman, 1992; Williamson & Shneiderman, 1992). The faceted navigation contained two types of controls: check boxes for selecting values that could not be described with a range (field of study, author) and a slider that represented time of publication (Fig 3.4). A new query was formulated with every interaction with the controls. If two or more check boxes were

checked, the resulting query includes each of the selected items as a parameter (Fig 3.5). For example, in “Field of Study”, the user could select both “Software Industry” and “Design” items, which would yield results combining the two. In addition, facet items from different sections could also be selected to further narrow the query and limit the results to things of interest to the searcher, while still maintaining an uninterrupted view of the interface. If the date slider was manipulated, the date range of the resulting articles/resources narrowed or expanded based on the position of the start and end year handles dragged by the user (Fig 3.6).

The results section in the original design provided a title, an abstract, a list of authors, and citation count. This type of information was considered useful for users by the researcher because it could indicate the importance, relevance, and significance of a resource. However, the system used for retrieving data for this prototype did not allow direct access to the abstracts and a citation count.

litscout

genetic mutations

**FIELD OF STUDY**

- Gene Mutation (1,540)
- Genetic Research (1,098)
- Medical Research (954)
- Cancer Research (711)

**A genetic screen for mutations affecting embryogenesis in zebrafish**  
W. Driever, L. Solnica-krezel, A. Schier, S. Neuhauss, J. Malicki, D. Stemple, D. Stainier, F. Zwartkruis, S. Abdelilah, Z. Rangini, 1995  
Cited by 432

**Genetic Origin of Mutations Predisposing to Retinoblastoma**  
Webster Cavenee, Marc Hansen, Magnus Nordenskjold, Eric Kock, Irene Maumenee, Jeremy Squire, Robert Phillips, Brenda Gallie, 1985  
Retinoblastoma is one of several human tumors to which predisposition can be inherited. Molecular genetic analysis of several nonheritable cases has led to the hypothesis that this tumor develops after the occurrence of specific mitotic events involving human chromosome 13. These events reveal initial predisposing recessive mutations. Evidence is presented that similar chromosomal events occur in tumors from heritable cases.  
Cited by 97

**Cystic fibrosis population carrier screening: 2004 revision of American College of Medical Genetics mutation panel**  
Michael Watson, Garry Cutting, Robert Desnick, Deborah Driscoll, Katherine Klinger, Michael Mennuti, Glenn Palomaki, Bradley Popovich, Victoria Pratt, Elizabeth Rohrs, Charles Strom, C. Richards, David Witt, Wayne Grody, 2004  
experiencing challenges in delivering this service. 4 The current CF Foundation patient mutation database includes nearly double the number of CF patient chromosomes available for analysis in 2000. This report summarizes the major recommendations of our Working Group with the supporting justification for these decisions. A number of articles in this issue of Genetics in Medicine provide some  
Cited by 100

**Trends in lignin modification: a comprehensive analysis of the effects of genetic manipulations/mutations on lignification and vascular integrity**  
Aldwin Anterola, Norman Lewis, 2002  
A comprehensive assessment of lignin configuration in transgenic and mutant plants is long overdue. This review thus undertook the systematic analysis of trends

**Figure 3.4.** Original dynamic queries interface design

litscout

genetic mutations

**FIELD OF STUDY**

- Gene Mutation (1,540)
- Genetic Research (1,098)
- Medical Research (954)
- Cancer Research (711)

**A genetic screen for mutations affecting embryogenesis in zebrafish**  
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Michael Watson, Garry Cutting, Robert Desnick, Deborah Driscoll, Katherine Klinger, Michael Mennuti, Glenn Palomaki, Bradley Popovich, Victoria Pratt, Elizabeth Rohrs, Charles Strom, C. Richards, David Witt, Wayne Grody, 2004

**Figure 3.5.** Ability to select multiple facet options

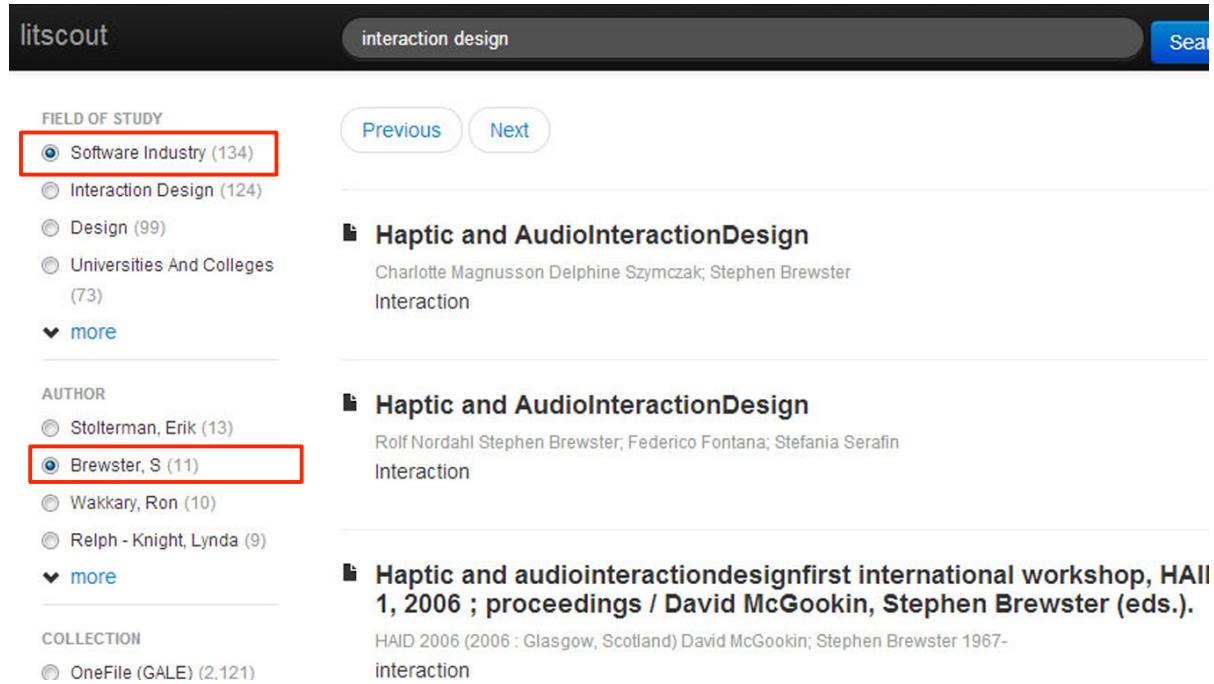


**Figure 3.6.** Slider control represents the year of publication

### 3.1.2 Revised Design

After the original design was finished and development work on the prototype was initiated, the researcher ran into problems with the back-end. The Microsoft Academic Search API, which was initially considered for data retrieval, proved unreliable. As an alternative, a website crawling script was developed that retrieved results from Iowa State University's library search engine. This posed some limitations to the way data were obtained. The method did not allow for multiple facet items from one facet section to be queried. For example, a query with more than two authors returned an error. To resolve this problem, the researcher used radio buttons instead of check boxes. The radio buttons limited the user to selecting only one facet item from the facet section. For example, the searcher could select only one author from the "Author" facet. Nevertheless, facet options from different facets like "Field of Study" and "Author" could be selected together (Fig 3.7). This

permitted a query to span multiple facets.



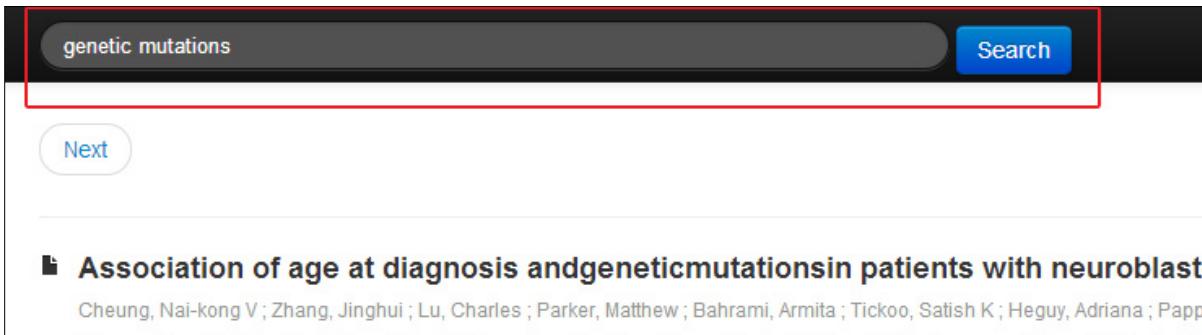
The screenshot shows a search interface for 'interaction design' on the 'litscout' platform. On the left, there's a sidebar with a 'FIELD OF STUDY' section containing several facet options: Software Industry (134), Interaction Design (124), Design (99), Universities And Colleges (73), and a 'more' link. The 'Software Industry' option is highlighted with a red box. Below it is an 'AUTHOR' section with Stolerman, Erik (13) and Brewster, S (11), where 'Brewster, S (11)' is also highlighted with a red box. At the bottom of the sidebar is a 'COLLECTION' section with OneFile (GALE) (2,121). At the top right, there are 'Previous' and 'Next' buttons. The main results area shows three items, each with a small icon, the title 'Haptic and AudioInteractionDesign', and a brief description. The first item is by Charlotte Magnusson, Delphine Szymczak, and Stephen Brewster, with the subtitle 'Interaction'. The second item is by Rolf Nordahl, Stephen Brewster, Federico Fontana, and Stefania Serafin, with the subtitle 'Interaction'. The third item is a workshop proceedings edited by David McGookin and Stephen Brewster, with the subtitle 'HAID 2006 (2006 : Glasgow, Scotland) David McGookin; Stephen Brewster 1967- interaction'.

**Figure 3.7.** Multi-select of facet options from different facets

### 3.1.3 Interface Layout and Functionality

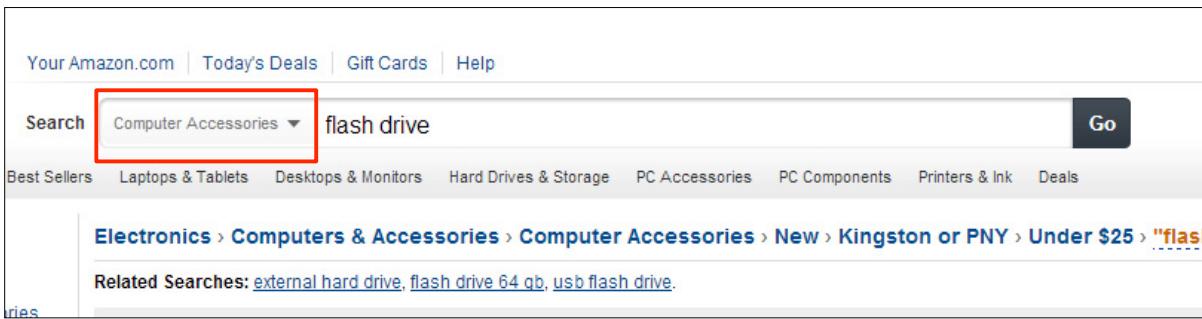
Both the dynamic queries and the regular facet interfaces displayed a search box screen as their homepage (Fig. 3.1). The only call to action on that screen was to search by keywords, similar to Google Scholar’s homepage. The homepage design gave the user an initial step to getting to a related result set. This approach of getting in the right “neighborhood” of research was supported in the literature review (White & Roth, 2009). The main screen consisted of a keyword search box at the top, a faceted navigation in the left panel, and a results list in the center. As studies of faceted search interfaces and e-commerce examples showed, this is the predominant type of layout for faceted interfaces (English,

Hearst, Sinha, Swearingen, & Lee, 2002; Kules, Capra, Banta, & Sierra, 2009; Kules & Shneiderman, 2008; Tunkelang, 2009; White & Roth, 2009). The keyword search box initiated a new search (Fig 3.8). When the user submitted a new query using this input, the system reset both the faceted navigation and the results list. This allowed the search to be restarted, if the previous results did not meet the end goal criteria.



**Figure 3.8.** Search box in the header.

Aside from renewing the search, there were other methods of search box behavior that were also considered. According to Tunkelang (2009), the conventional approach dictates that a new keyword entry cleans all filters. However, another option is to offer users a selection whether they want to search within a narrowed set (“search within these results”), or similarly to Amazon, display a filter drop-down/label in the search box to indicate that the user will be querying within the current category (Fig 3.9).



**Figure 3.9.** Amazon uses a drop-down within the search box to denote that a new search will query only data within that drop-down category.

Below the header with the search box, the user could find the left panel reserved for the faceted navigation. The prototype implements the following facets: “Field of Study”, “Authors”, “Collection”, “Resource Type”. The “Field of Study” facet included all the topics and areas of research related to the current search results. “Authors” pulled in all the major authors who have articles/books related to the searched area of study. “Collection” listed all major journals and conferences in connection to the current search. “Resource Type” listed the type of documents available e.g. articles and books.

Results were displayed on the right side of the faceted navigation, in the center of the interface. The chosen layout of left panel faceted navigation, paired with results content in the center, is the prevalent type of layout for faceted search interfaces according to Tunkelang (2009). It is also dominant in the studies discussed in Chapter 2. With this type of layout the results section gets more prominence. Hence, it is more likely that users will easily see the results and focus on them (Tunkelang, 2009).

As discussed in Chapter 2, faceted search is not a new concept. All of the major e-commerce websites use a left-panel-center-stage layout, which makes it popular among users and therefore, a good choice for a new interface because of familiarity. In addition, it can

contribute to the “tight coupling” between the faceted search browsing and results thus allowing searchers to quickly see examples (Kules & Shneiderman, 2008) in response to their query parameters.

By clicking on any of the facet options, the system formulated a query that was used to retrieve data through the back-end scripts. In the case of the dynamic queries interface, this was done in the background and results were displayed immediately, while keeping the interaction undisturbed. The regular facet interface, on the other hand, acted like a regular web page. When the user clicked on one of the facet links, the page reloaded with new data for both the results section and the faceted navigation. This interrupted the interaction between the user and the search engine but also allowed for a drill down into sub-category facet options (Fig 3.11).

**itscout**

interaction design

FIELD OF STUDY

- Learning (5,461)**
- Design (2,705)
- Interaction (2,234)
- Human (1,713)
- Human Computer Interaction (1,589)
- Affect (1,572)
- Man-machine Systems (528)
- Online Information Services (443)
- Ubiquitous Computing (443)
- Industrial Design (353)

**AUTHOR**

**Interaction Design**  
Stender, Ilka  
Hochparterre : Zeitschrift für Architektur und Design, 2001, Vol.14(11)

**Thoughts on Interaction Design**  
Jon Kolko Chris Connors  
2010

**Study on the application of Interaction Design to Children's Me**

**tscout**

interaction design

FIELD OF STUDY

- Learning-Physiology (512)**
- Learning-Research (258)
- Learning-Drug Effects (150)
- Learning-Methods (101)

**AUTHOR**

- Jochems, Wim (3)
- Van Orden, G C (2)
- Alvarez, Edgardo O (2)
- Alvarez, EO (2)

**COLLECTION**

SciVerse ScienceDirect

**Interaction design studio learning in virtual worlds**  
Vosinakis, Spyros ; Koutsabasis, Panayiotis  
Virtual Reality, 2013, Vol.17(1), pp.59-75 [Peer Reviewed Journal]

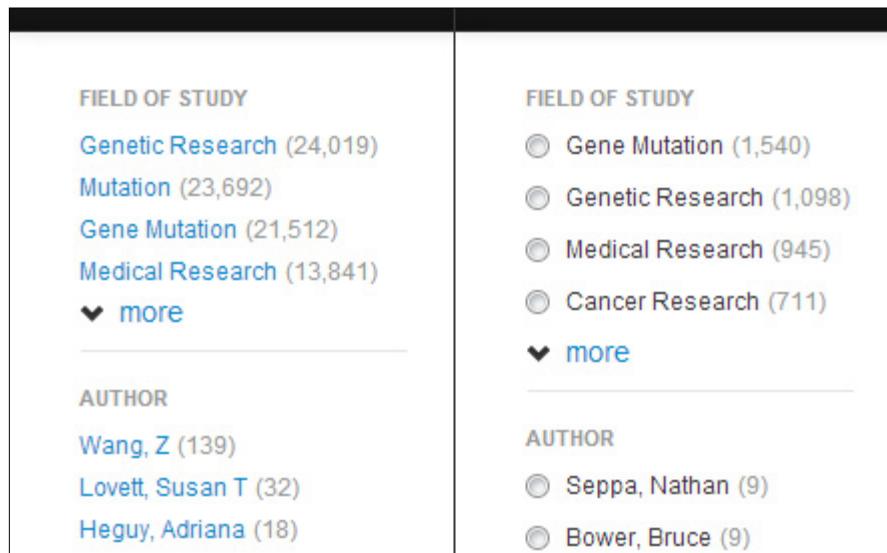
**TUIs vs. GUIs: comparing the learning potential with preschoolers**  
Sylla, Cristina ; Branco, Pedro ; Coutinho, Clara ; Coquet, Eduarda  
Personal and Ubiquitous Computing, 2012, Vol.16(4). pp.421-432 [Peer Reviewed Journal]

**Human-oriented interaction with an anthropomorphic robot**

**Figure 3.11.** Regular faceted search: drill down into sub-categories

In the dynamic queries prototype, the user selected facet options by clicking the facet radio buttons (Fig 3.12). The user could select facet options from all available facets to filter down the query, but only one facet option could be selected per facet. In other words, in the example given (Fig 3.12), the user can select “Gene Mutation” but is not able to select both “Gene Mutation” and “Genetic Research”. However, the user is able to select “Gene

Mutation” from “Field of Study” and “Bower, Bruce” from “Author”, which will generate a query filtering all works in “Gene Mutation” from “Bower, Bruce”. As mentioned previously in this chapter, the original design envisioned multiple item selection from a facet using check boxes, but due to some technical difficulties during the development of the prototype, the radio button style of interaction was selected.

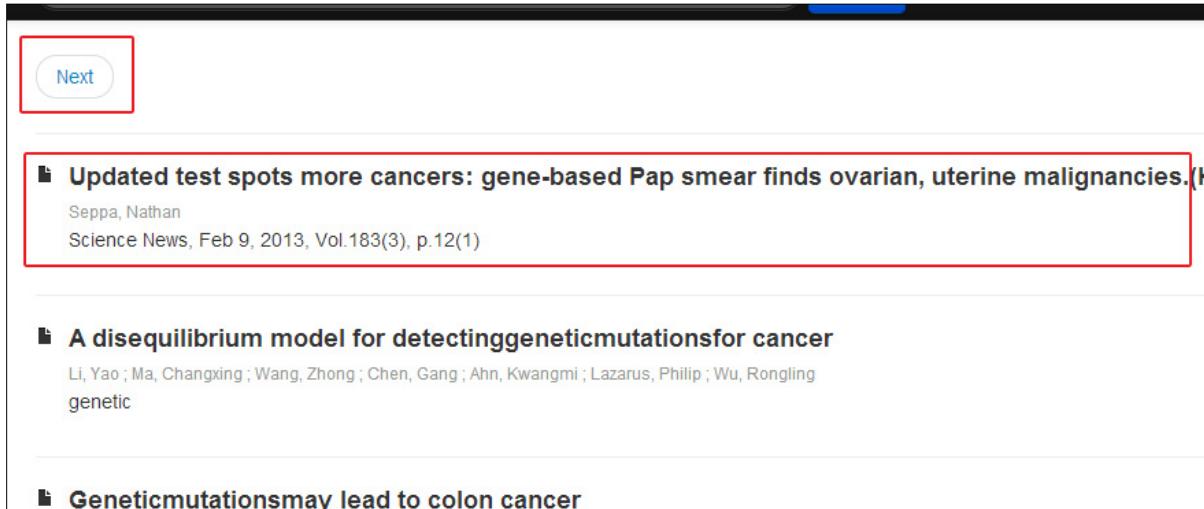


**Figure 3.12.** Facet link navigation (regular) vs. dynamic facet navigation

Both facet navigation panels displayed only the first four items for each facet. To view the rest, the user could select “more” button. In addition, every facet option in both navigation styles displayed the amount of resources available, which could serve as guidance to the option's popularity and amount of work contained within. This representation of the available resources was supported by the review in Chapter 2 (Ahlberg, Williamson, & Shneiderman, 1992; Shneiderman, 1994).

The search results were displayed to the right of the faceted navigation for both

interfaces. Each result item was represented by the resource title, its authors, and the journal/publication details. The initial design also included an abstract and citation count within the result item but due to technical difficulties during the development of the prototype discussed previously in the chapter, this feature had to be dismissed. Above the result items sat a paging navigation with “next” and “previous” options and allowed the user to review more than just the initial ten results (Fig 3.13).



**Figure 3.13.** The results section: displays a resource's title, author, and publication. Paging navigation at the top.

The result items were initially designed to be links to full articles. However, due to time constraints and technical limitations, the final prototype did not allow users to open the selected resource. Nevertheless, this type of functionality is not essential for testing the type of faceted navigation interaction, which was the goal of this thesis study.

## 3.2 Prototype Development

### 3.2.1 Prototype Development: Back-end

In order to create an authentic search experience for this study's participants, the prototype had to provide real data, which corresponded to the user's query parameters. There is no practical way to predict all possible queries related to the tasks given to a participant, which makes data retrieval particularly important for accurate study results.

Initially, the prototype utilized Microsoft's Academic Search API (Application Programming Language). This service provided the required data: resource title, type, authors, journal/conference, abstract, amount of citations, rank, etc. However, a couple of weeks prior to the studies, the service was constantly down for maintenance without a strict schedule or announcement. This issue forced the researcher to find an alternative way of returning query results.

As an alternative the researcher developed a crawling script in PHP, a web server-side scripting language. The script sends an HTTP (Hyper Text Transfer Protocol) request directly to the Iowa State University's library search engine (Fig 3.14). Following this, the raw HTML is extracted by the PHP script and processed. During the processing, the PHP script parses through the DOM (Document Object Model) to retrieve data only from elements that are needed: faceted navigation, result items, paging navigation. Then the raw data is injected into the study's prototypes (Fig 3.15). This process is repeated every time a new query is submitted.

IOWA STATE UNIVERSITY  
e-Library

Quick Search  
genetic mutations

Search Advanced Search

Expand My Results

Show only

Refine My Results

Creator

More options ▾

Results 1 - 10 of 525,100 for this search

sorted by: relevance

1 2 3 4 5 ▾

**Association of age at diagnosis and genetic mutations in patients with neuroblastoma**

Cheung, Nai-kong V.; Zhang, Jinghu; Lu, Charles; Parker, Matthew; Bahrami, Armita; Tickoo, Satish K.; Heguy, Adriana; Pappo, Alberto S.; Federico, Sara; Dalton, James; Cheung, Irene Y.; Ding, Li; Fulton, Robert; Wang, Jianmin; Chen, Xiang; Becksfort, Jared; Wu, Jianrong; Billups, Catherine A.; Ellison, David; Mardis, Elaine R.; Wilson, Richard K.; Downing, James R.; Dyer, Michael A.

JAMA : the journal of the American Medical Association, 2012, Vol.307(10), pp.1062-71 [Peer Reviewed Journal]

● Full text available

Online resource Details . . . Reviews & Tags Additional services

**Teasing apart cancer's influences.(CANCER GENETICS)(Brief article)**

Nature, Feb 10, 2011, Vol.470(7333), p.143(1) [Peer Reviewed Journal]

progression of tumours with these mutations? A team led by Allan Balmain at the University of California, San Francisco, studied how germline genetic

● Full text available

Online resource Details . . . Reviews & Tags Additional services

**Alzheimer's in a dish.(CELL BIOLOGY)(Brief article)**

Nature, August 11, 2011, Vol.476(7359), p.129(1) [Peer Reviewed Journal]

in cells from people with Alzheimer's mutations this... mutations produced higher levels of a protein fragment... of three patients with genetic mutations

● Full text available

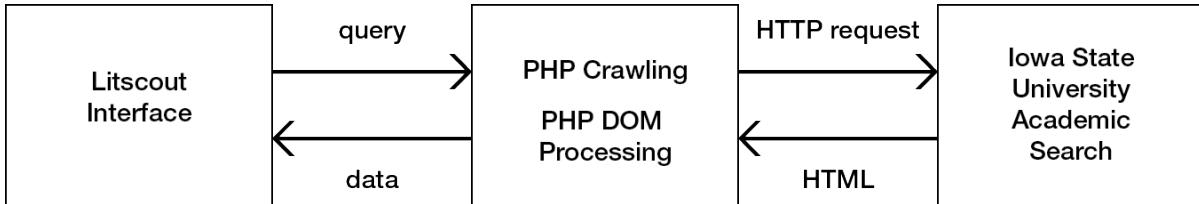
Online resource Details . . . Reviews & Tags Additional services

View all versions

View all versions

View all versions

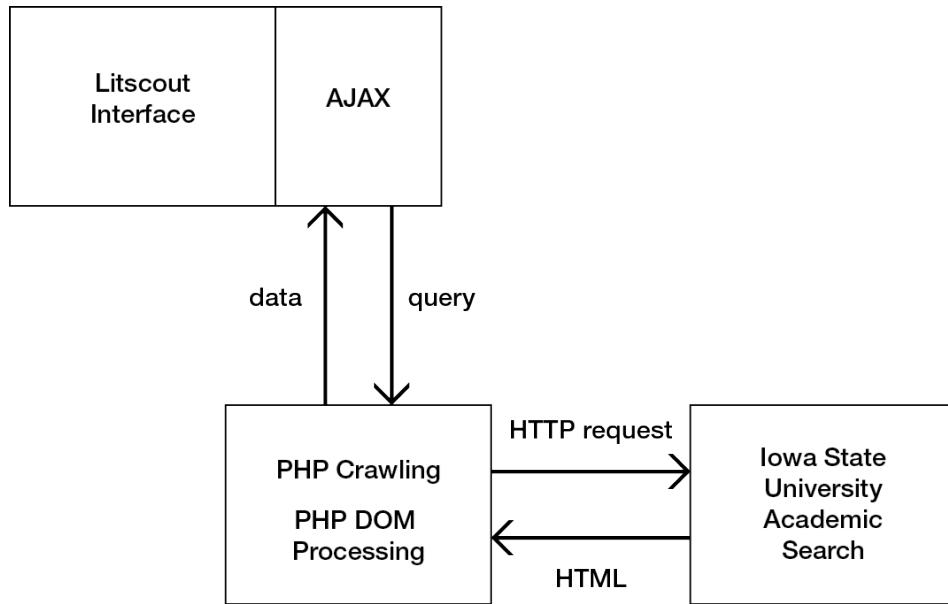
**Figure 3.14.** Iowa State Library search powered by Primo.



**Figure 3.15.** Data retrieval process.

In addition to PHP crawling scripts, the dynamic queries prototype required the use of AJAX (Asynchronous JavaScript and XML) to retrieve data dynamically without interrupting the user's interaction with the system. As mentioned in Chapter 2, AJAX is a conglomeration of several established technologies that serve content in the background. This avoids the need for page reload which disrupts the user's interaction with a website or a web application. In the case of the dynamic queries prototype, AJAX is used to formulate the facets query based on user selections, and send the query parameters to the PHP crawling

script. When the PHP script returns the requested data, the AJAX script places the results into the results section of the search interface (Fig 3.16).



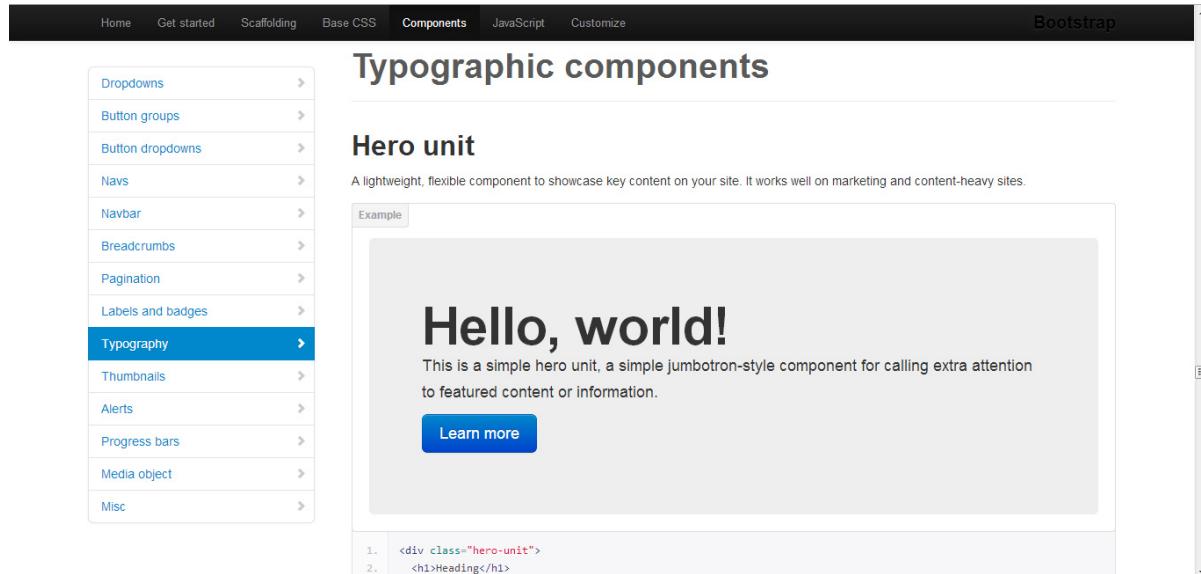
**Figure 3.16.** AJAX data retrieval process.

The Iowa State University's library search system was chosen for data retrieval because it conducts a federated search and provides a faceted navigation, features that were essential for this study.

### 3.2.2 Prototype Development: Front-end

The front-end, also known as the client, of the prototype was created using the Twitter Bootstrap UI code library (Fig 3.17). Bootstrap provides a variety of components built in standards compliant HTML, CSS and JavaScript. The code library includes all of the necessary components needed for the prototype: search box, buttons, typography, etc. In addition, the visual style of Bootstrap is very widespread and widely used in many web

applications. This makes it an appropriate choice for prototype development in a study that examines types of interaction rather than graphics design. Furthermore, Bootstrap comes with good support documentation and allows for quick prototyping and development.



**Figure 3.17.** Twitter Bootstrap website

### 3.3 User Studies

The researcher conducted user testing to assess the usability of both interfaces and discover which interaction style improves the exploratory search process for users, as well as improves user satisfaction and enjoyment. The study included a pre-survey, followed by task-based scenarios using the two interface systems on a PC laptop computer, a post-survey and exit interviews. The screen-based prototypes were presented to potential users. All participants were students from Iowa State University. The study collected information about user demographics, user feedback, user comments, time spent on task, user system ratings, and researcher observations.

### **3.3.1 Participants**

The interface systems were tested with a total of twelve participants, all of whom were students from Iowa State University. The small sample size was considered standard for usability studies (Nielsen & Landauer, 1993). The sample pool included both undergraduate and graduate students. Testing with both groups was done to reveal any potential differences in their approach to academic search. The initial hypothesis was that graduate students will employ different and, possibly, more successful search strategies because of richer research experience.

To recruit students, printed flyers with the study announcement were posted on bullet boards around campus (Appendix 1). Word of mouth and email were also used (Appendix 2). Those who responded were contacted by a follow-up email regarding the time and location of the study (Appendix 3).

### **3.3.2 Materials and Procedure**

Twelve students that responded to the flyer or the recruitment email participated in the study. The testing sessions took place in a quiet studio for about an hour each. Each subject received and signed a copy of the informed consent documents. An introduction script of the study was also presented. Following this, participants filled out a survey, which asked about demographic information: age, gender, native language, student status (graduate or undergraduate) (Appendix 4). In order to get an insight into the users' research habits, the survey contained questions about the participants' use of scholarly tools and resources. The survey questions were designed to show if there is any dependency or correlation between search habits based on demographics and interaction with the provided prototypes.

After completion of the pre-survey, participants were presented with four tasks/scenarios that described what type of search activity they needed to complete (Appendix 5). Each scenario was designed to emulate a classroom/research type of situation. The students had to generate research topics and find resources (articles and authors) using the two prototypes sequentially. For example, in task one, the participant had to find two possible topics starting with Interface 1, and then two other using Interface 2. This order was alternated for tasks three and four. Furthermore, the interface order was reversed for each participant that followed. This was done to guarantee effective and comparable results between the two systems.

When creating exploratory search tasks/scenarios, they need to be devised to induce an exploratory search. Task design for this study followed the recommendations presented by Kules and Capra (2008). Accordingly, an exploratory search scenario has to be described in a way that requires learning and investigation. The two goals were achieved by including more complex terms and by avoiding direct-answer questions. Kules and Capra (2008) also suggest that the scenario has to describe a familiar situation for the participant. In this study, the search scenarios are related to class projects. In addition, Kules and Capra (2008) indicate that the scenarios should stimulate the need for discovery by creating uncertainty about requirements and topics. Following this guideline, the researcher designed tasks that encouraged participants to explore how two or more novelty topics are connected. Furthermore, the lack of previous knowledge about terms supports Kules and Capra's (2008) point of selecting scenarios and subject matter that are unfamiliar to the participant.

Kules and Capra (2008) give a good template for formulating an exploratory search

scenario:

*Imagine that you are taking a class called \_\_\_\_\_. For this class, you need to write a paper on the topic \_\_\_\_\_. Use the catalog to find two possible topics for your paper. Find three books for each topic.*

The following is one of the tasks/scenarios used for this research study:

*Imagine that you are taking a class called “Geological Disasters”. For this class, you need to write a paper exploring the relationship between Earthquakes and Safety Measures. Use interface 1 and then interface 2 to find two possible topics for your paper and write them down. Check the corresponding checkbox for each one.*

The objective of each task/scenario was to place the participant in a familiar situation (a class setting) in which multiple items would need to be found. In addition, each task/scenario aimed at topic assignments that are open-ended and/or target multiple items as results, which makes them more likely to elicit exploratory search behaviors (Wildemuth & Freund, 2012).

During task completion, participants checked the corresponding check box for each article/book. Each task was timed for each interface. Subjects were asked to think out loud. The think aloud protocol was used to get an insight into the participant's thought process. It also allowed to get an immediate feedback on satisfaction, usefulness, usability, engagement, enjoyment, and self-reported level of understanding of the content. These are primary measures of a successful ESS according to Capra, Marchionini, & Oh (2007). In addition, the researcher observed each step of the search process and recorded each participant's search strategy.

After completion of all tasks, the researcher occasionally asked questions based on the participant's performance. The researcher conducted this informal exit interview to gain an insight into why users did certain things during the study. This type of interview can be very beneficial especially when participants do not follow the "think aloud" protocol.

Further assessment of both interfaces was obtained through a post-survey (Appendix 6). The questionnaire required participants to rate each system based on ease of use, ability to learn, provided content, information organization, and overall satisfaction. One of the main goals of the survey was to find which interface users found more satisfactory and helped them learn/understand the research topics better. The rating system was based on a seven-point scale, where seven points correspond to "strongly agree".

## CHAPTER 4. USER STUDY RESULTS

This chapter is divided into several parts. The first part describes the results from the pre-survey, which participants filled out before initiating the interface test. The second part describes the qualitative and quantitative measures of the two interfaces based on time per task and user systems rating collected via a post-survey questionnaire. In the post-survey, participants had to rate the two systems by ease of use, ease of learning, provided results and topic understanding, and clear organization. The third part describes the content analysis of comments collected from participants during the course of each study. Finally, this chapter also summarizes the researcher's observations during the user tests.

### 4.1 Pre-Survey Results

A pre-survey was conducted with all 12 participants in the study. Participants were asked about demographic information: age, gender, native language, and student status (graduate or undergraduate) (Appendix 4). The survey also questioned the participants' use of academic search resources, such as Google Scholar, and overall search experience.

#### 4.1.1 Participant Demographics

Participants in this study were both graduate and undergraduate students. There were 7 undergraduate (58%) and 5 graduate students (42%). One of the goals of the study was to see how undergraduates measure against graduates when using an academic search engine. Age was also a potential metric with impact on the interface testing results that the researcher wanted to take into consideration. There were 7 participants in the age group of 18-23 (58%), 3 participants in 24-29 (25%), 1 participant in 30-35 (10%), and 1 participant at the age of

54-59 (10%). The male/female ratio was 1/3: 3 participants were male (25%) and 9 participants were female (75%). All participants were native English speakers, except one but she had lived in the USA for most of her life and speaks English fluently.

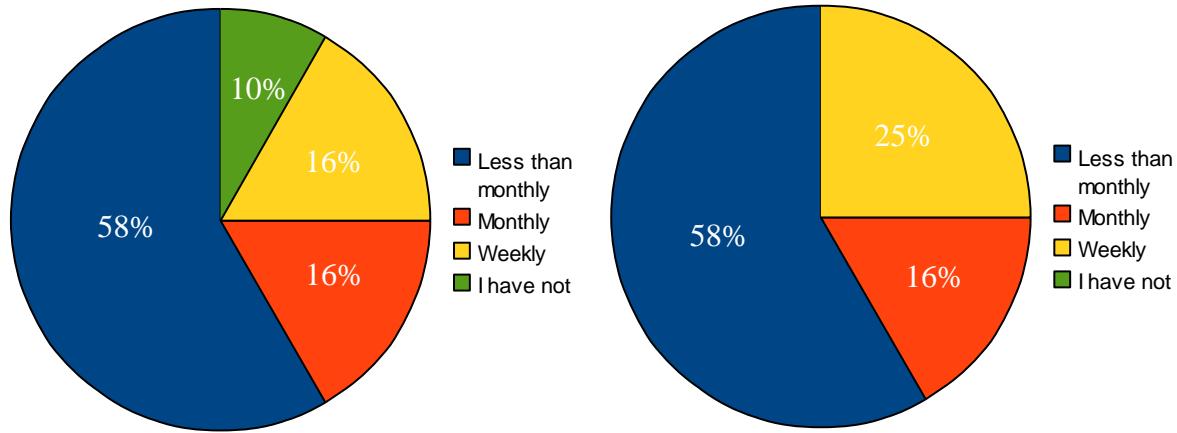
Participant #	Age	Gender	Native language	Student status
1	24-29	Male	English	Graduate
2	18-23	Female	English	Graduate
3	18-23	Female	English	Undergraduate
4	18-23	Male	English	Undergraduate
5	18-23	Female	English	Undergraduate
6	18-23	Female	English	Undergraduate
7	24-29	Female	French	Graduate
8	24-29	Female	English	Graduate
9	18-23	Female	English	Undergraduate
10	18-23	Female	English	Undergraduate
11	30-35	Male	English	Graduate
12	54-59	Female	English	Undergraduate

**Figure 4.1.** Demographic information

#### 4.1.2 Participants' Use of Research Tools and Research Experience

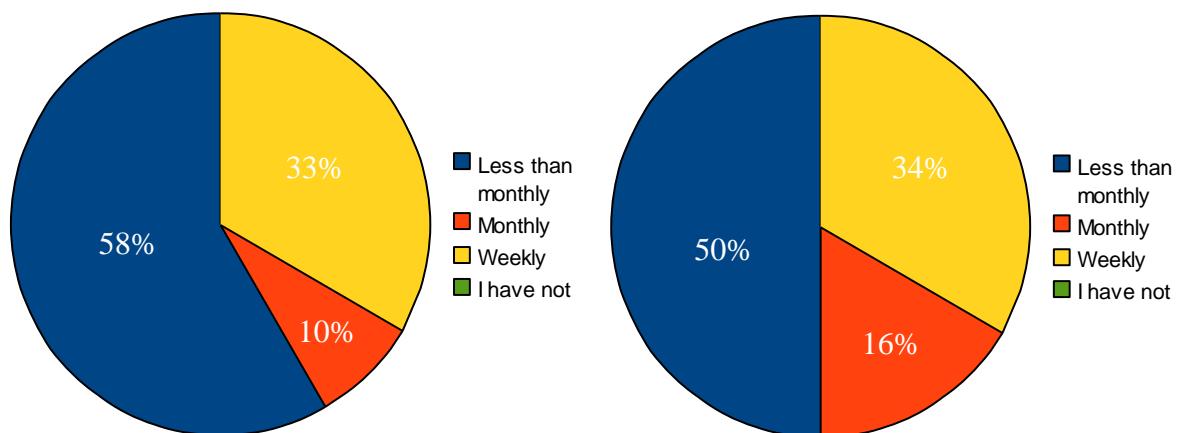
In the second part of the survey, participants were asked to rate their research experience. This information was collected to give an insight into the users' research habits. On the question "How often do you write research papers?", 7 participants (answered "Less than monthly", 2 participants answered "Monthly" (16%), another 2 answered "Weekly"

(16%), and 1 answered “I have not” (10%). When participants were asked “How often do you use the ISU online library?”, 7 participants (58%) answered “Less than monthly”, 2 participants answered “Monthly” (16%), and 3 answered “Weekly” (25%). When asked “How often do you use article databases?”, 7 participants (58%) answered “Less than monthly”, 4 answered “Weekly” (33%), and 1 answered “Monthly” (10%). These results are portrayed in Fig 4.2.1 – 4.2.4.



**Figure 4.2.1.** How often do you write research papers?

**Figure 4.2.2.** How often do you use the ISU online library?



**Figure 4.2.3.** How often do you use article databases?

**Figure 4.2.4.** How often do you use Google Scholar?

Participant #	Write research papers	Use ISU online library	Use Article Databases	Use Google Scholar	Asking for help
1	Less than monthly	Less than monthly	Weekly	Weekly	Occasionally
2	Monthly	Monthly	Monthly	Weekly	Never
3	Less than monthly	Less than monthly	Less than monthly	Less than monthly	Occasionally
4	Less than monthly	Less than monthly	Less than monthly	Less than monthly	Occasionally
5	Less than monthly	Less than monthly	Less than monthly	Less than monthly	Occasionally
6	Less than monthly	Less than monthly	Less than monthly	Less than monthly	More often than not
7	Less than monthly	Less than monthly	Less than monthly	Less than monthly	Occasionally
8	Weekly	Weekly	Weekly	Weekly	Never
9	I have not	Less than monthly	Less than monthly	Monthly	Occasionally
10	Monthly	Weekly	Weekly	Weekly	Never
11	Weekly	Weekly	Weekly	Monthly	Occasionally
12	Less than monthly	Monthly	Less than monthly	Less than monthly	Occasionally

**Figure 4.3.** Research experience and use of academic search resources

There was a significant percentage (58%) of participants who did not conduct research on a regular basis. This can be explained with the fact that there were a larger number of undergraduate participants in the sample pool. However, there was one graduate participant who also answered “Less than monthly” on majority of the research experience questions. In other words, being a graduate student does not constitute much research experience. However, this phenomenon needs additional studies and the small number of

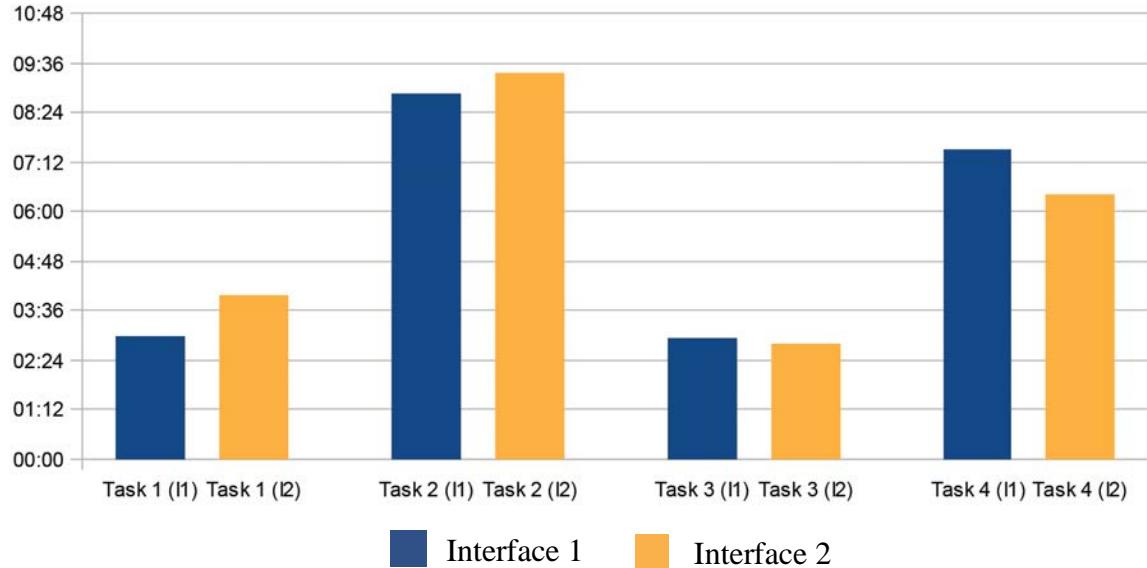
survey participants cannot give significant statistical results to generalize.

## 4.2 Tasks

Participants were timed while performing each of the required tasks. Their interaction with each interface was observed. The researcher recorded their steps in the search process. In addition, subjects were asked to talk aloud while conducting the study, which was also recorded by the researcher. Finally, in a post-study interview, participants were asked questions based on their performance and actions.

### 4.2.1 Task Time

Each task was timed for both Interface 1 and Interface 2. The average times for all tasks and corresponding interface were calculated. They are as follows (in minutes): Task 1: Interface 1 - 02:57, Interface 2 – 03:57; Task 2: Interface 1 – 08:51, Interface 2 – 09:20; Task 3: Interface 1 – 02:56, Interface 2 – 02:48; Task 4: Interface 1 – 07:29, Interface 2 – 06:24. The following bar graph represents these times visually (Fig 4.4).



**Figure 4.4.** Average times per task and interface

As seen in Fig 4.4, there is a significant difference in the time it took to complete Task 1 and Task 3 as opposed to Task 2 and Task 4. This can be explained by the nature of the tasks. Task 1 and Task 3 only required from the participant to find two possible topics for a paper, whereas Task 2 and Task 4 required finding two topics and resources (articles/books) to support these topics (resources that will be cited in their papers) (Appendix 5). These tasks were more challenging, as they required testers to use critical thinking to go beyond simple topic formulation and find resources that will help them support their investigation.

The chart in Fig 4.4 shows a slight decline in the time it took participants to complete the tasks. This is not so evident from Task 1 and Task 3 but there is a significant difference in times between Task 2 and Task 4. The difference can be explained with participants learning how to use the system and being more efficient in their searches. One of the subjects

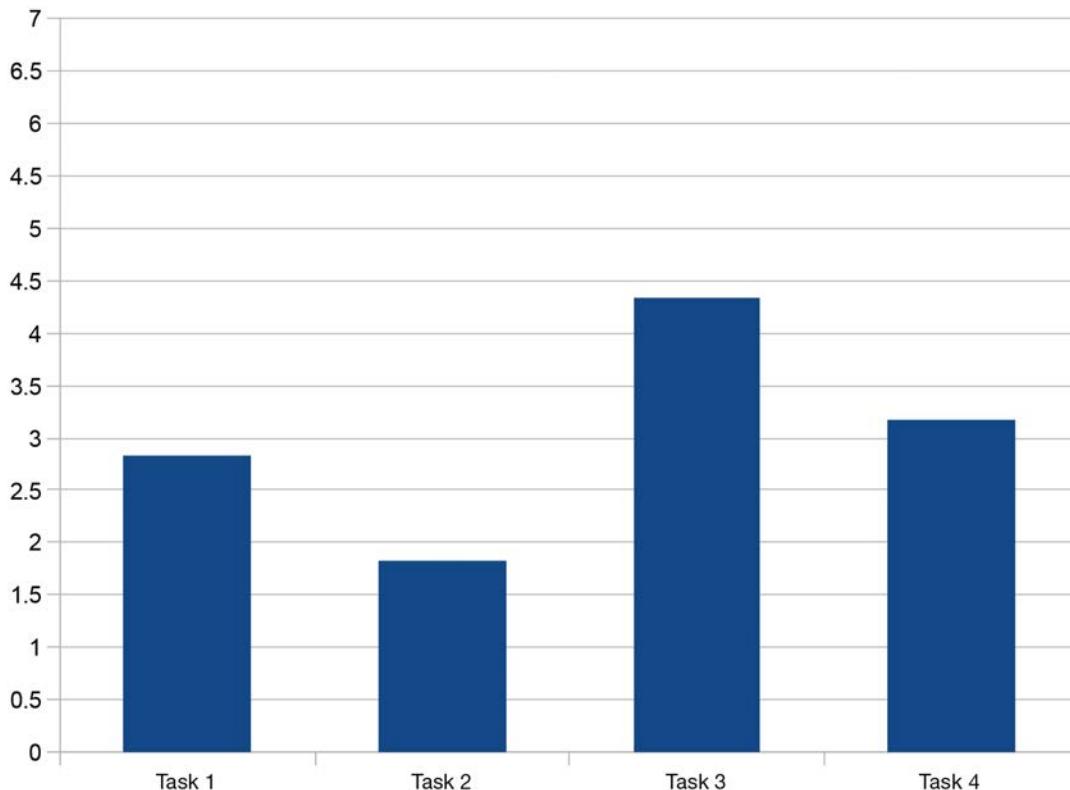
commented, "I noticed I'm getting better with it. It takes me less time to find resources." The researcher observed that 4 users did not notice the facets immediately. Some participants started using the facet navigation as late as Task 3. The faster times for Task 4 can then be attributed not only to getting familiarized with the systems' interface, but also with the use of the faceted navigation.

Some participants spent a significant amount of time working on the search tasks. One participant spent 18 minutes and 39 seconds using Interface 2 for Task 2. In any other studies, this user might have been interrupted and asked to move to the next task. However, the researcher wanted to facilitate a situation that imitated a real-life setting as close as possible, therefore participants were allowed to take as much as they needed to search the system. Furthermore, exploratory searches often span longer periods of time, as people are not simply looking up facts but are trying to understand a field of study (Marchionini, 2006).

The average time results are not conclusive about interface performance. The researcher did not find any significant time differences for the use of the two interfaces. When compared, the prototypes performed at almost equal rates. The researcher expected faster times for the dynamic queries search based on previous studies described in Chapter 2 (Ahlberg, Williamson, & Shneiderman, 1992; Shneiderman, 1994). However, this is the first study (to the researcher's knowledge) that compares regular faceted search to dynamic queries specifically for academic content. One also needs to take into account that the dynamic queries interface was stripped from some of the original functionality, which could have had impact on time. Since time on task did not give conclusive results, other measures were analyzed more in-depth.

### 4.3 Post-Survey Results

In addition to quantitative measures such as time, the two interfaces were compared based on feedback received from the post-survey. One of the aims of the post-survey was to discover how familiar participants were with each task topic prior and after the study to identify whether the system stimulated their learning and understanding. Also, each interface received quality ratings. On the question “How familiar were you with the subject you were asked to find research for?”, the average rating for all tasks, except Task 3, is below 3.5 on a seven point scale: Task 1 – 2.83, Task 2 – 1.83, Task 3 – 4.33, Task 4 – 3.17. (Fig 4.5). The result shows that participants had some general knowledge but it was limited.

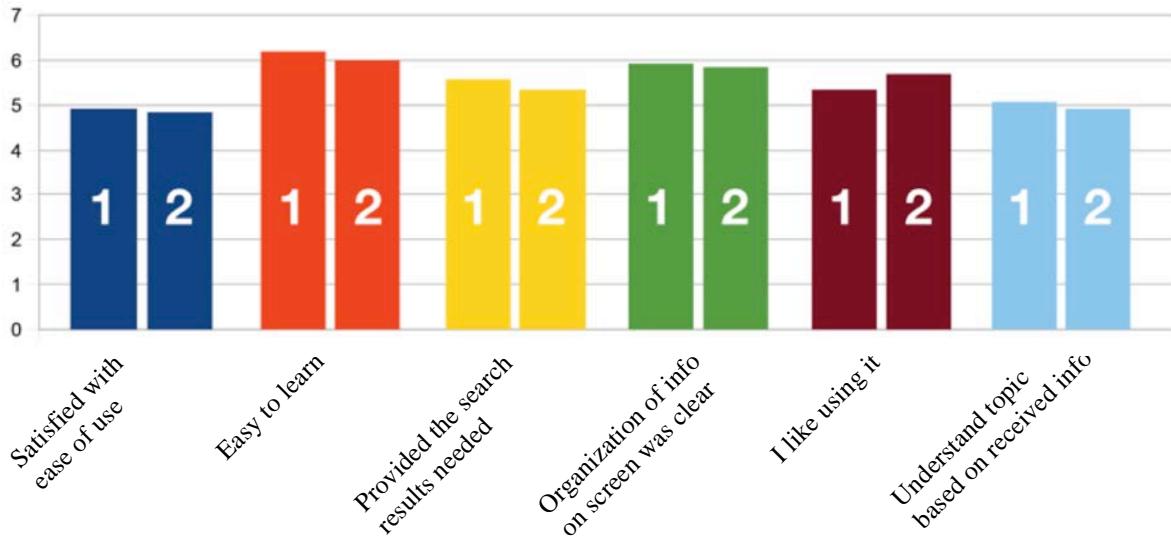


**Figure 4.5.** Average rating related to user familiarity with the topics in each task

Subjects rated several statements (Appendix 6)(Fig 4.6). The statement “Overall, I am satisfied with how easy it is to use this system” aimed at assessing the ease of use of each interface. The issue of effectively learning how to use the interface was rated by the following: “It was easy to learn to use this system”. As discussed in Chapter 2, learnability is important when measuring the effectiveness of an exploratory search system. Subject confidence with the completion of the search tasks was assessed with the following statement: “The system provided the search results needed to complete the task”. With “The organization of information on the system screens is clear” the researcher wanted to see how the participants perceived layout and functions. The statement “I like using the interface of this system” aimed to get an overall satisfaction rating. Finally, “I understand the topic area and related research based on the information I received from the system” was included to see if subjects felt more confident about the searched topics after using the interface to research them. This measure was important for the assessment of participants’ learning and understanding of the explored material, which is one of the main goals of an ESS.

The results from the survey show above 3.5 rating scores on a scale 1 to 7 for both systems. When comparing the average scores for each interface, there are no significant differences in quality and performance between the two systems. This was surprising to the researcher. It was expected that the dynamic queries navigation interface would score higher than the regular facet search. One possible explanation for these results could be the limitations of the dynamic queries prototype, mentioned in Chapter 3.

The post-survey results were inconclusive when comparing the two systems. Therefore further analysis was conducted based on participant comments and feedback.



**Figure 4.6.** Average rating scores for each system: Interface One (1) and Interface Two (2)

#### 4.4. Content Analysis

Both time measurements and user ratings did not produce conclusive results. To obtain a better perspective of how each system performed with users, a content analysis was conducted summarizing all relevant user comments during the studies. The comments were placed under several categories based on their content: “prototype limitations” summarizes any comments related to limitations of any of the interfaces; “interface layout and functionality” describes anything said about interface elements other than the faceted navigation; “dynamic queries navigation” points to all comments about the dynamic queries search interface; “regular faceted navigation” summarizes everything said about the second “regular” interface; “suggestions” gathered suggestions for possible improvements made by users; “general” summarizes all other recorded comments made during the study.

After placing the comments under their appropriate categories, comment occurrences

per user were counted. Similar comments were combined, adding together the number of times they were mentioned. This analysis was conducted after no conclusive results were received from quantitative measures such as time on task and system ratings. It is an additional measure that combines qualitative and quantitative data. The researcher predicted that this method would help compare the two interfaces and establish the benefits and downfalls of each interaction method, as well as suggest ways for improvement.

The two interaction styles are compared based on the summary of comments specific to them (Fig 4.7-4.8).

Dynamic queries navigation	Mentioned
Dynamic queries navigation provided too broad categories, while regular facet was more specific and allowed me to drill into the categories.	2
Radio buttons feel more like a filter rather than a set choice/ show better what is filtered	2
How do I uncheck?	1
The radio buttons gave me more control and the ability to narrow down the results.	1
I like the dynamic queries navigation.	1
I like the radio buttons and clicking on them.	1
The radio buttons make me feel limited.	1

**Figure 4.7.** Summary of comments specific to dynamic queries navigation

Regular faceted navigation	Mentioned
I like that it narrows the results down (drill down); makes them more specific	4
I did not like how clicking on links makes the facets go away/shift;	3
I like using links; prefer clicking on the words	2
How do I unfilter / return to previous results	2
There is no feedback on what is filtered – confusing; radio buttons show what is filtered.	1
Interface 2 better and considered the content to be better.	1
I like Interface 2 more than 1	1

**Figure 4.8.** Summary of comments specific to regular faceted navigation

The summaries related to the two styles of interaction show that users felt strongly about the narrowing down of the results through the navigation. Two participants criticized the dynamic queries navigation for showing only broad categories and lacking the ability to “drill-down” into the categories. On the other hand, the regular facet navigation was praised for supporting this feature. Four subjects considered a positive trait being able to get to more specific results. For example, if the user selects “Genetic Mutations” from the “Field of study” facet, this will reload the page with new search results, and the facets will display options only related to “Genetic Mutations”.

However, the regular facet navigation was criticized in other ways. Three participants disliked the way it shifted the facets when they drilled down into the categories. For example, when “Genetic Mutations” is selected from “Field of Study” and there are no related sub-categories, the facet collapses (does not display any content) and relocates the other facets in an upward direction to fill in the space. The subjects might be irritated because it interrupts their search process: instead of focusing on the results, the user needs to shift his/her

attention to the new state of the navigation and figure out what has changed, why it has changed, and how it affects the current search. The dynamic queries navigation does not alter the facets. Therefore it can be argued that it sustains the user's focus on the search results and how they change based on facet selection. Nevertheless, the dynamic queries navigation can benefit from ways to introduce facet sub-categories/sub-options.

Participants also commented on how the interfaces indicated what was filtered. In the comment summaries, both the dynamic queries and regular facet approaches received feedback related to this problem. There were comments that radio buttons felt more like filters. This can be explained with the nature of radio button controls. When a radio button is selected, it changes its state to "filled-in" which gives the user a reference to what is currently "filtered". Such visual indication helps the user to see immediately what is "in-use" and to easily analyze how that affects the results. This supports the design guideline of "tight coupling" of results and navigation (White & Roth, 2009). On the other hand, participants also felt limited by the radio buttons. They could only select one per facet and they could not uncheck it.

As for the regular facet navigation, some participants (2) were unhappy with how the interface lacked the ability to remove filters once a facet option was clicked. The subjects had to go back to the previous screen by clicking on the "back" button of the browser. It was also mentioned that there was no clear feedback from the system on what/how results were filtered. The comments suggest the dynamic queries navigation is overall a better solution for informing the user what is filtered.

In addition to comments specific to each interaction style, participants expressed

thoughts related to other parts of the user interface. They talked about different components, as well as their experience conducting the tasks in the scenarios (Fig 4.9-4.12). The comments about layout and functionality are summarized in Fig 4.9. Several participants (3) pointed out some flaws of the paging navigation. There was a shared understanding that the navigation needs to be repeated at the bottom. The same subjects commented that it was hard to find the buttons. Some were not sure about the button functionality because of the lack of labels denoting it. Other comments in that summary suggest that participants found facets “Field of Study” and “Author” particularly helpful when deciding on topics.

Fig 4.9 and Fig 4.10 show that participants wanted to use the “save for later” function. Both prototypes had a check box “save this” for each resource item in the search results. However, it was not fully functional at the time of the study. The comments suggest that subjects would have used this feature in their search process, if it was available to them. The user testing shows the need for it to be fully implemented for future studies.

Fig 4.10 points out some of the limitations that were apparent in the prototypes. As one can see from the comments, some participants (3) expressed frustration with the presentation of the results section. They commented on the lack of indicators to show the importance/ranking of a resource. A citation count, as participants pointed out, could serve this purpose. Another limitation recognized by subjects was the inability to open the resource for further investigation.

Interface layout and functionality	Mentioned
Hard to find the next button; did not use paging because it lacked options; I want to have the page navigation at the bottom	3
Found looking at “Field of study” to help him decide on a topic	2
Author facet, helpful when picking author	2
I like the save later function	1
Hierarchically the results section was much stronger; it was more “in my face” and made me focus on it much more	1
The amount of results next to each facet is overwhelming and I think it would be inefficient to try to look through them	1
The amount of sections in the faceted navigation was overwhelming	1

**Figure 4.9.** Summary of comments about layout and functionality

Prototype limitations	Mentioned
I want to use the “save” feature but it was not available for me	4
Titles not clickable, expected to be clickable	3
Results do not show how they are cited. No way to understand how they are sorted	2
A lot of articles in different languages	1
Expected the dynamic drop down result list similar to Google's when using the search bar	1
Titles lose space between words	1

**Figure 4.10.** Summary of comments pointing to prototype limitations

While going through the tasks, some of the more outspoken participants shared ideas of how the interaction could be improved (Fig 4.11). It is interesting to see that two participants felt that check boxes would work better than radio buttons. This also confirms the initial design, which used check boxes for facet option selection, as a better solution for dynamic search. Other comments suggest the use of filters within the search box. Chapter 2

showed that this type of feature is implemented in some e-commerce websites such as Amazon. Another good comment was to develop “article chaining” as in Google. “Article chaining” allows an article to link back and forth to all articles that have been cited or are citing it.

Suggestions	Mentioned
Expected/interested in seeing how this could work with check boxes instead of radio	2
I like Google Scholar's chaining to related articles	1
Would be helpful if one could search by author or collection within the search box.	1
I expected to see breadcrumb-style navigation	1
I would add row striping when a save check is selected	1

**Figure 4.11.** Summary of participant suggestions

General	Mentioned
I don't know how to explore thing I know nothing about; results are confusing	2
I noticed I'm getting better with it. Takes me less time to find resources.	2
The lack of knowledge on the subject frustrates me	1
I did not use facets for filtering the results. I'm so accustomed to search engines that don't have navigation	1
Didn't find the faceted navigation helpful, seemed like it moved results away from the topic.	1
I really enjoy research and found this study fun because there was no pressure	1
Typically would formulate the topic before finding the papers but since I am unfamiliar with the topic, I write the topic after finding papers.	1
I don't see the differences between these two interfaces	1
Took awhile to figure out the facet navigation bar. I think it's because I was focused on the results and the tasks in the beginning and didn't explore the interface thoroughly.	1

**Figure 4.12.** Summary of general comments

#### 4.5 Researcher Observations

During the course of each user study, the researcher observed and recorded the actions of the participants (Appendix 7). From user observations and user feedback, it becomes apparent that both faceted navigation styles were not immediately apparent to all participants. Four subjects (33%) did not notice the facets immediately. Some participants started using the facet navigation as late as Task 3. There was one subject in particular who completely ignored the facets and referred only to the results section. Instead of using the facets to narrow down the result set and/or explore different sub-topics, she kept refining her keyword queries. When asked if she noticed the facets and why she did not use them, the participant explained that she thought the number of sections (facets) in the faceted navigation was overwhelming. She also found the amount of resource results that are in parentheses next to each facet item overwhelming and she believed it would be inefficient to try to look through them.

This extreme case and the preceding ones can be related to the lack of research experience of the participants. The subject, who completely ignored the facets, later commented that she used to do mostly visual research rather than textual research. In the pre-survey she answered “less than monthly” for all four questions related to conducting academic research online. Similarly the other four participants, who ignored the facets in the beginning of the study, selected “less than monthly” for the same four questions. One of these subjects commented that the reason it took her awhile to figure out the facet navigation was because she focused mainly on the results and the tasks in the beginning, and did not explore the interface thoroughly.

Another reason for overlooking the facets could be that these participants and most millennial users (born in the late 1980s and early 1990s) are primarily familiar with web search engines without features like facets. Websites/services like Google do not offer facets or any other form of filtering to accompany the keyword search box. One participant commented, “I am so accustomed to search engines that don't have this type of navigation”.

User habits cannot be changed easily but certain alterations in the interface layout can increase facets visibility. According to Tunkelang (2009), setting the facets in a left panel and the results section in the center, places the focus on the latter. He notes that this type of layout can be too subtle for less sophisticated users who are likely to omit anything that is not directly in front of them. Tunkelang (2009) proposes a solution of placing the facets above the results, which makes them immediately noticeable. However, this type of layout reduces the space available for search results and users are forced to make more effort. Another solution, described by Kules & Capra (2012) is to show a brief demonstration of working with the facets. In their study this approach increased facets use significantly. They argue that without external nudge, some searchers may not adapt their tactics to take advantage of such features.

On the other hand, for participants who discovered and used the faceted navigation in the study, it proved to be a useful tool based on their feedback and actions. The facet “Field of study” was most popular and was used to both narrow down the result set and inform new keyword search queries. One user looked at “Field of study” for help on picking topics. The same participant used the facet to repeatedly explore different result sets and narrow down by sub-topics. Most of the participants used a combination of keyword search and facet queries. The typical user approach was to start with a keyword search, analyze the results set and the

resulting facets, and revise the keyword search, if needed. During the study, this process sequence was often repeated several times by users until they reached satisfying results. Similarly, in the study by Kules & Capra (2012), participants' gaze behavior constantly switched between the facets and the result set.

## CHAPTER 5. CONCLUSION

New technologies are transforming academic search in a dramatic fashion and have created a demand for convenience and immediacy. The review of literature shows that an effective online scholarly tool needs to engage users in an exploratory process. One of the main goals of the thesis was to find and test interaction techniques to achieve that. The research pointed to faceted interfaces, which allow users to both browse and use keywords to navigate through the information space.

Another technique identified during the review was the use of dynamic queries. It has the potential to provide more immediate and playful feel to the search process through more visual, instant and non-disruptive user-interface interaction. The conducted user studies aimed at discovering how effective dynamic queries interfaces can be for academic searches and whether they improve the user experience.

Two prototypes were developed and tested with users to compare dynamic queries to regular facet navigation style. The two interfaces were tested for search efficiency and user satisfaction measured through time on task, user system ratings and user comments/feedback. The results do not conclude that the dynamic queries style is a more effective and satisfying way of search interaction, as hypothesized by the researcher. Topic learning/understanding rates were also similar. This can be due to some of the limitations in the prototype development discussed in Chapter 3. However, the conducted content analysis of participants' verbal reactions during each test session helped point to the strengths and weaknesses of each interface.

One of the major strengths of the dynamic queries prototype was its stability and

predictability: facets remained constant after selection; the interaction between the participant and the system was uninterrupted and thus users did not have to shift their focus. In contrast, the regular facet interface irritated subjects by constantly reloading the page and shifting the facets order. Participants also saw the dynamic queries interface as a better indicator of what was filtered, making it more successful in the “tight coupling” between navigation and results.

The regular facet prototype’s main strength was the delivery of more in-depth results. Participants were able to “drill-down” into the facets (reveal sub-categories) to find more specific resources for their tasks. In comparison, the dynamic version showed only broad categories (the top level facets) and therefore limited the possible results. The narrow down feature is a guideline by White and Roth (2009) (discussed in Chapter2) for a successful ESS. However, according to Kules and Shneiderman (2008) and taking Amazon’s example into consideration, the navigation needs to display the facets in a hierarchy to avoid a limited view of the research topic(s).

### 5.1 Future Research

The results of the study suggest several directions for future research. There will be technical revisions of the prototypes to resolve the limitations discussed in Chapter 3. This will allow for more robust dynamic queries interface with features from the original design such as: multi-select check box navigation, a date slider, abstract and citation count. Future prototype iterations will also incorporate a drill-down approach to the dynamic queries navigation to reveal subcategory facets, as it proved to be a desired feature by participants in the study. However, it will be devised to show the information hierarchy. The “save for later”

is another feature which received positive feedback and will also be implemented. More research on different types of widgets and interface layout can show alternative ways of interacting with academic resources. Future studies will also explore more graphic representations of the data, such as colored bars to represent the facet items and the amount of resources they contain (Capra & Marchionini, 2008).

## 5.2 Limitations

There were several limitations to this research. First and foremost, there were some technical difficulties related to the programming of the prototype. The developed script to retrieve scholarly resources proved limited. Thus the prototype design was altered from its original version: radio buttons were used instead of check boxes which did not permit more than one selection per facet; the date slider widget was omitted; search results did not display abstracts or citation count. Besides technical difficulties, this study also had a limited number of participants (12 in total). A larger and more diverse participant pool could give more accurate results.

APPENDIX 1. RECRUITMENT FLYER

# PARTICIPANTS NEEDED To Test an Interface

**Are you over 18 years old?**

**Are you willing to spend approximately  
60 minutes to participate in the testing of 2  
interfaces?**

**If you are interested in participating in this study, please  
contact Stefan Ganchev at [sganchev@iastate.edu](mailto:sganchev@iastate.edu)**

**APPENDIX 2. RECRUITMENT EMAIL**

Dear Student,

If you are 18 years or older, I would like to invite you to participate in a research study comparing three different interface systems at Iowa State University. This study involves the interface design of two journal article search systems and aims at finding which system delivers a better user experience and which one makes the search process easier.

Before the study begins, I will provide a form for you to give consent to be interviewed. If you agree to participate, you will be asked to complete a brief survey about your use of online library resources and search engines. After completion of the survey, you will be asked to complete a series of tasks on 2 different interface systems. During the study, you will be observed, video will be recorded of the screen activity (your identity and facial expression will not be recorded, in addition to your identity being kept confidential), and mouse movements will be tracked and recorded. After completing the task sequence with both systems, an exit survey will be conducted to collect feedback about your overall experience and to learn how you compare the two systems. This process could take up to ONE HOUR of your time; although the process may or may not take the entire time.

You DO NOT have to answer any questions that make you uncomfortable.

If you agree to participate in this study, please contact me at using the information below. Thank you for your consideration.

Stefan Ganchev

**APPENDIX 3. FOLLOW UP EMAIL**

Thank you very much for agreeing to participate in this study.

Your participation will contribute to the continuing research on best interaction design practices for journal articles search.

The study will take place at \_\_\_\_\_. Please, use this [calendar](#) to sign up for an open spot. This study will consist with three stages: 1) filling out the user information, 2) conducting tasks, and 3) filling out the exit survey.

This study will last approximately 60 minutes. You need to be at least 18 years of age to participate.

If you have any questions, please let me know.

Thank you,

Stefan Ganchev

## APPENDIX 4. PRE SURVEY

1. Age
- |                                 |                                |                                |                                  |
|---------------------------------|--------------------------------|--------------------------------|----------------------------------|
| <input type="checkbox"/> 18- 23 | <input type="checkbox"/> 24-29 | <input type="checkbox"/> 30-35 | <input type="checkbox"/> 36-41   |
| <input type="checkbox"/> 42- 47 | <input type="checkbox"/> 48-53 | <input type="checkbox"/> 54-59 | <input type="checkbox"/> Over 60 |
2. Gender
- |                               |                                 |
|-------------------------------|---------------------------------|
| <input type="checkbox"/> Male | <input type="checkbox"/> Female |
|-------------------------------|---------------------------------|
3. Native language
- |                                  |                                 |
|----------------------------------|---------------------------------|
| <input type="checkbox"/> English | □ Other (Please specify: _____) |
|----------------------------------|---------------------------------|
4. Student status
- |  |                                   |
|--|-----------------------------------|
| <input type="checkbox"/> Undergraduate | <input type="checkbox"/> Graduate |
|--|-----------------------------------|
5. How often do you write research papers?
- |  |  |                                  |                                 |
|--|--|----------------------------------|---------------------------------|
| <input type="checkbox"/> I have not used | <input type="checkbox"/> Less than Monthly | <input type="checkbox"/> Monthly | <input type="checkbox"/> Weekly |
|  |  |                                  | <input type="checkbox"/> Daily  |
6. How often do you use the ISU online library?
- |  |  |                                  |                                 |
|--|--|----------------------------------|---------------------------------|
| <input type="checkbox"/> I have not used | <input type="checkbox"/> Less than Monthly | <input type="checkbox"/> Monthly | <input type="checkbox"/> Weekly |
|  |  |                                  | <input type="checkbox"/> Daily  |
7. How often do you use article databases?
- |  |  |                                  |                                 |
|--|--|----------------------------------|---------------------------------|
| <input type="checkbox"/> I have not used | <input type="checkbox"/> Less than Monthly | <input type="checkbox"/> Monthly | <input type="checkbox"/> Weekly |
|  |  |                                  | <input type="checkbox"/> Daily  |
8. How often do you use Google Scholar?
- |  |  |                                  |                                 |
|--|--|----------------------------------|---------------------------------|
| <input type="checkbox"/> I have not used | <input type="checkbox"/> Less than Monthly | <input type="checkbox"/> Monthly | <input type="checkbox"/> Weekly |
|  |  |                                  | <input type="checkbox"/> Daily  |
9. How often do you ask for help from a librarian, instructor, etc., when conducting research?
- |                                |                                       |  |                                 |
|--------------------------------|---------------------------------------|--|---------------------------------|
| <input type="checkbox"/> Never | <input type="checkbox"/> Occasionally | <input type="checkbox"/> More often than not | <input type="checkbox"/> Always |
|--------------------------------|---------------------------------------|--|---------------------------------|

## APPENDIX 5. TASKS

### Task 1

Imagine that you are taking a class called “Geological Disasters”. For this class, you need to write a paper exploring the relationship between *Earthquakes* and *Safety Measures*. Use interface 1 and then interface 2 to find two possible topics for your paper and write them down. Check the corresponding checkbox for each one.

### Task 2

Imagine that you are taking a class called “Theoretical Physics”. For this class, you need to write a final paper exploring the relationship between *Black Holes* and *Matter*. Two possible topics are due in class today. The class is about to start. Use interface 1 and then interface 2 to find two possible topics for your paper and write them down. Find three articles and/or books for each topic. Check the corresponding checkbox for each one. Choose 2 authors on one of your topics and write them down for further exploration later on in the semester.

### Task 3

Imagine that you are taking a class called “Globalization and Sustainability”. For this class, you need to write a paper exploring the relationship between *Energy* and *Sustainability*. Use interface 2 and then interface 1 to find two possible topics for your paper and write them down. Check the corresponding checkbox for each one.

### Task 4

Imagine that you are taking a class called “Plant and Animal Science”. For this class, you need to write a paper exploring the relationship between *Genetics* and another area of science. Use interface 2 and then interface 1 to find two possible topics for your paper and write them down. Find three articles and/or books for each topic. Check the corresponding checkbox for each one. Choose 2 authors on one of your topics and write them down for further exploration later on in the semester.

## APPENDIX 6. POST SURVEY

1. How familiar were you with the subject you were asked to find research for?

Task 1:

1     2     3     4     5     6     7 *very familiar*

Task 2:

1     2     3     4     5     6     7 *very familiar*

Task 3:

1     2     3     4     5     6     7 *very familiar*

Task 4:

1     2     3     4     5     6     7 *very familiar*

2. Overall, I am satisfied with how easy it is to use this system:

System 1:

1     2     3     4     5     6     7 *strongly agree*

System 2:

1     2     3     4     5     6     7 *strongly agree*

3. It was easy to learn to use this system:

System 1:

1     2     3     4     5     6     7 *strongly agree*

System 2:

1     2     3     4     5     6     7 *strongly agree*

4. The system provided the search results needed to complete the task:

System 1:

1     2     3     4     5     6     7 *strongly agree*

System 2:

1     2     3     4     5     6     7 *strongly agree*

5. The organization of information on the system screens is clear:

System 1:

1     2     3     4     5     6     7 *strongly agree*

System 2:

1     2     3     4     5     6     7 *strongly agree*

6. I like using the interface of this system:

System 1:

1     2     3     4     5     6     7 *strongly agree*

System 2:

1     2     3     4     5     6     7 *strongly agree*

7. I understand the topic area and related research based on the information I received from the system:

System 1:

1     2     3     4     5     6     7 *strongly agree*

System 2:

1     2     3     4     5     6     7 *strongly agree*

8. Please provide any additional comments below:

## APPENDIX 7. STUDY NOTES

**User 1**

(limitation) **Comment:** Results do not show how they are cited

(limitation) User had to write topics freehand: took longer to complete tasks

Overwhelming use of “Field of study” facet and “Author”

(limitation) **Comment:** Desired to have the page navigation at the bottom

(limitation) Inaccurate spacing between words.

(limitation) No filter removal as it is present on Primo search. Forced the participant to use the “back”

**Comment:** Initially liked the radios but they were not giving him the drill down into a topic desired for deeper research of a topic.

**Task 1 (I1):**

**Comment:** How do I uncheck?

Used “Field of study” facet

**Time:** 4:20

**Task 1 (I2):**

**Comment:** How do I unfilter? - confused

**Comment:** “Field of study” disappeared – user confused

**Time:** 3:46

**Task 2 (I1):**

Could not find the appropriate “Field of study” facet but looked for it for awhile

Used primarily the search bar for new results

Likes the radio buttons: feels more like a filter rather than a set choice

Used the “Author” facet and the specified number of publication to select authors

In the end used “Field of study” successfully

**Time:** 12:17

**Task 2 (I2):**

Did not look at the facets in the beginning

When started using the facets as filters, used the “back” button on browser to return to previous state.

Repeated key-word search

**Comment:** How is it sorted? By citation? Assumes they are all credible sources.

**Time:** 7:28

**Task 3 (I2):**

Used facet “Field of study”

Used “back” to unfilter the result set

**Time:** 3:40

**Task 3 (I1):**

Used “Field of study” facet

**Time:** 01:47

**Task 4 (I2):**

Struggled with initial key-words

Used “Field of study” facet to find pages related to topic

Found looking at “Field of study” to help him decide on a topic

Used the same facet to find related articles

Used “back” to unfilter

**Time:** 9:30

**Task 4(I1):**

Used “Field of study” to inform a new key-word search

Continued with key-word searches: learned from the “Field of study” facet

**Time:** 5:33

## User 2

(limitation) Spaces between words

(limitation) Filter results by language

(limitation) No feedback on what is filtered on I2: Primo shows “filters” for each facet selected

(limitation) No page nav at bottom

(limitation) No abstract available

(limitation) No citation points. No indication of how reputable an article is

**Comment:** Did not like how clicking on links makes the facets change (go away) - confusing

**Comment:** Liked the save later function

**Comment:** Likes Google Scholar's chaining to related articles

**Comment:** Interested in seeing how this could work with check boxes instead of radio

**Task 1 (I2):**

Used “Field of study” but did not like that results shifted and no easy way to return

No feedback on what is filtered – confusing; radio buttons show what is filtered

Used another key-word search inspired by facets “Field of study”

**Time:** 5:32

**Task 1 (I1):**

Played around a lot with the facets

Used facets “Field of study” and “Author”

**Time:** 5:20

**Task 2 (I2):**

Used key-word search to find articles

Used “Field of study” a lot to explore topics. Additionally used key-word in the hunt

**Time:** 9:00

**Task 2 (I1):**

key-word search + “Field of study”

**Time:** 4:38

**Task 3 (I1):**

Used “Field of study” to find the right topic

Used a combination of “Field of study” with key-word search to narrow results

**Time:** 3:47

**Task 3 (I2):**

Same

**Time:** 1:40

**Task 4(I1):**

Used “Field of study” to narrow results down. Tried different “Field of study” topics

**Time:** 5:40

**Task (I2):**

Drilled down “Field of study” facet

**Time:** 2:35

**User 3**

(limitation) Participant tried to select an “Author” facet together with “Field of study” to filter based on both.

(limitation) Titles not clickable, expected to be clickable

**Comment:** Author facet, helpful when picking author

Interface 2 better and considered the content to be better.

Prefers clicking on the words.

**Task 1 (I1):**

A lot of articles in different languages

Used only key-word search

**Time:** 1:30

**Task 1 (I2):**

Same

**Time:** 1:30

**Task 2 (I1):**

Used only key-word search in the beginning and ignored the facets

After several searches, discovered and started using “Field of study” which found very helpful

**Time:** 9:20

**Task 2 (I2):**

Used the drill down of facets to select topic

Noticed the change in “Authors” based on “Field of study” selection

Picked only the top authors from the “Author” facet for the author requirement of the task

**Time:** 9:30

**Task 3 (I2&I1):**

**Time:** 2:56

**Task 4 (I2):**

Used a combination of “Field of study” and key-word

**Comment:** The “Field of study” probably does not help span two topics but it narrows it down

**Time:** 4:16

**Task 4 (I1):**

Similar results

**Time:** 3:34

## User 4

(limitation) Surprised the titles were not clickable

Comment: I don't know how to explore thing I know nothing about

The participant's key-word search was very much like sentence: used "and" and other connectors.

Likes Interface 2 more than 1

The radio buttons gave him more control and the ability to narrow down the results

Comment: The lack of knowledge on the subject frustrated the participant

### Task 1(I2):

Started with a long key-word search

Refined it by another key-word search

Surprised the titles were not clickable

Kept referring only to the key-word search

Used "back" and "forth" buttons to unfilter and bring the filter back

**Time:** 4:45

### Task 1(I1):

First time he tried the facets but quickly gave up

**Time:** 00:30

### Task 2(I2):

Used only key word search query

User confused about what a topic is

Kept referring only to the key word search box

Refined the key word search

**Time:** 12:24

### Task 2(I1):

Started with key word search

Discovered the facets and filtered the results but gave up on it

**Time:** 12:32

### Task 3(I1):

Used the "Field of study" facet

**Time:** 4:30

### Task 3 (I2):

Kept referring mostly to the results and key-words only.

**Time:** 1:35

#### **Task 4 (I1)**

Used the “Field of study” from the beginning

Did not do much search for supporting articles

**Time:** 8:00

#### **Task 4 (I2):**

Used key-word search and explored the facets just briefly

**Time:** 4:27

### **User 5**

**For methodology:** The reason for an extensive task requirements for research is to try to simulate as much as possible a research challenge scenario where students are required to use journal article search engines.

(limitation) Participant expected titles to be clickable

**Comment:** where can I see my saved stuff?

**Comment:** Took awhile to figure out the facet navigation bar. I think it's because I was focused on the results and the tasks in the beginning and didn't explore the interface thoroughly.

#### **Task 1 (I1):**

When using key-word search, participant used phrases and sentences including “and”

Participant expected titles to be clickable

Used only key-word search, ignored the facets

**Comment:** where can I see my saved stuff?

Used paging navigation

**Time:** 2:30

#### **Task 1 (I2):**

Ignored facets

Used only key-word search, ignored the facets

**Time:** 2:30

#### **Task 2 (I1):**

When using key-word search, participant used phrases and sentences including “and”

Used only key-word search, ignored the facets

Used an author from the first result

Kept referring only to the search box  
 For topics, only grabbed the paper titles

**Time:** 9:55

**Task 2 (I2):**

Kept referring only to the search box  
 Used the paging navigation  
 Did not seem to explore more of the content but chose the first available results  
 Kept referring only to the search box

**Time:** 6:50

**Task 3 (I2):**

Used only key-word search, ignored the facets

**Time:** 3:00

**Task 3 (I1):**

Discovered the facet navigation bar  
 Used the “Field of study” facet to narrow down topics and papers (used it numerous times)  
**Time:** 2:34

**Task 4 (I2):**

Referred to “Field of study” facet after a key-word search  
 Used the “Field of study” facet to inform key-word decisions  
 Kept using the paper title as a topic  
 Used the “Field of study” facet to begin the search for the second topic instead of using key-word search

**Time:** 9:30

**Task 4 (I1):**

Used “Field of study” facet and paging navigation  
 Several explorations of the “Field of study” facet  
**Time:** 5:31

## **User 6**

**Comment:** Hard to find the next button, I thought it would be at the bottom

**Comment:** Would be helpful if one could search by author or collection (filter on the search box)

**Comment:** Expected the dynamic drop down result list similar to Google's when using the search bar

**Comment:** I want to use the “save” feature but it was not available for me

**Task 1 (I2):**

Used paging navigation to view more results

Did not use any of the facets

**Time:** 2:45

**Task 1 (I1):**

Used only key-word search

**Time:** 2:24

**Task 2 (I2):**

When using key-word search, participant used phrases and sentences including “and”

Looked at the facets but did not use them

Used only key-word search

Used the author facet to select from a major author

Selected author from the “Author” facet

**Time:** 6:25

**Task 2 (I1):**

Looked at the “Author” facet and tried to key-word search the author

**Comment:** Would be helpful if one could search by author or collection (filter on the search box)

Explored the “Field of study” facet and used it to inform key-word search refinement but this not click on any of the radios.

**Time:** 7:37

**Task 3 (I1 and I2):**

Used only key-word search

**Time:** 0:49

**Time:** 1:25

**Task 4 (I1):**

Used the topic “Genetics” and the word “and” for a key-word search. Interesting

Used the results to inform new key-word searches

Ignored the facets

Selected an author from one of the selected papers

Informed the key-word search by exploring the “Field of study” facet

**Time:** 6:56

**Task 4 (I2):**

Explored the “Field of study” facet after initial key-word search.

Selected one of the facets from “Field of study” related to the topic

For topic 2, started the search by looking at the “Field of study” facet

Conducted key-word search based on facet observation

Drilled down into the “Field of study” facet generated by the key-word search

**Time:** 4:14

**User 7**

Completely ignored the facets:

Thought the amount of sections in the faceted navigation was overwhelming. Also the amount of results next to each facet was overwhelming and she believed it would be inefficient to try to look through them.

Hierarchically the results section was much stronger; it was more “in her face” and made her focus on it much more

Did not use the paging navigation to see more results

**Comment:** Doesn't do research often anymore. More visual than paper research

**Task 1 (I1):**

When using key-word search, participant used phrases and sentences including “and”

Uses the results to inform the topic

Used only key-word search

Submitted actual topics

**Time:** 3:12

**Task 1 (I2):**

When using key-word search, participant used phrases and sentences including “and”

Uses the results to inform the topic

Used only key-word search

Submitted actual topics

**Time:** 1:54

**Task 2 (I1):**

Ignores the facets

Used only key-word search

Used only articles from the initial result set (no use of paging)

Did not try to refine the result set

**Time:** 7:20

#### **Task 2 (I2):**

Ignores the facets

Used only key-word search

Used only articles from the initial result set (no use of paging)

Did not try to refine the result set

**Time:** 5:09

#### **Task 3 (I2):**

Used only key-word search

Used only articles from the initial result set (no use of paging)

**Comment:** Knew more about the topic so she did not rely on the results as much

**Time:** 1:05

#### **Task 3 (I1):**

Used only key-word search

Used only articles from the initial result set (no use of paging)

**Comment:** Knew more about the topic so she did not rely on the results as much

**Time:** 1:08

#### **Task 4 (I2):**

Used only key-word search

**Comment:** Relied more on her personal knowledge for this topic

Refined the key-word search

**Time:** 10:25

#### **Task 4 (I1):**

Used only key-word search

Looking at the search results for topic ideas

Refined the key-word search several times

**Time:** 14:00

## User 8

(limitation) **Comment:** no description of the article

**Comment:** Did not notice the paging navigation. Expected to see paging at the bottom.

Did not use facets for filtering the results:

So accustomed to search engines that don't have navigation

When shown the dynamic vs regular faceted navigation, participant selected the former as her choice.

### Task 1 (I2):

Used only key-word search

**Time:** 4:40

### Task 1 (I1):

Used only key-word search

**Time:** 1:47

### Task 2 (I2):

Referred only to the search box

Refined key-words based on results

**Time:** 7:52

### Task 2 (I1):

Referred only to the search box

Refined key-words based on results

Used the “Author” facet to find authors

**Time:** 4:43

### Task 3 (I1):

Used only key-word search

Ignored facets again

Kept refining the key-word search

**Time:** 2:42

### Task 3 (I2):

Used only key-word search

Ignored facets again

Kept refining the key-word search

**Time:** 3:02

**Task 4 (I1):**

- Used only key-word search
- Ignored facets again
- Kept refining the key-word search
- Selected author from “Author” facet but did not start using the faceted navigation

**Time:** 5:30

**Task 4 (I2):**

- Used only key-word search
- Ignored facets again
- Kept refining the key-word search

**Time:** 2:18

## User 9

Note: might not be exploring the interface because of the pressures that come from testing

Note: used phrases for searches (word + and + word)

Comment: Didn't find the faceted navigation helpful, seemed like it moved results away from the topic.

Comment: Did not use paging because of the lack of options within the page navigation (no results: 1-11). Didn't realize “next” means next page

**Task 1(I1):**

- Started the search with keywords
- Refined the search by keywords
- Refined the key word search based on results
- Only used first page results
- Ignored facets

**Time:** 3:00

**Task 1(I2):**

- Key word search only
- Refined key word search based on results
- Looked only at 1<sup>st</sup> page results
- Ignored facets

**Time:** 3:03

**Task 2(I1):**

Started with key word search

Noticed the facets and clicked on “Field of study” facet but didn't use it any further

Refined the keyword search based on search results

Selected papers only from the first page results

Ignored facets for all aspects of the task

**Time:** 9:29

**Task 2(I2):**

Used key-word search

Refined the key-words several times

Started using the “Field of study” facet to find more results

Combination of key-words search and facet browsing but did not continue to use it

Selected papers only from 1<sup>st</sup> page

Selected authors only from the results

Informed new key word searches by the results

**Time:** 7:46

**Task 3(I2):**

Started with a new key word search

Refined the key word search

Used only key-word search

**Time:** 2:42

**Task 3(I1):**

Started with key-word search

Selected the topic based on the results received from the key-word search

**Time:** 1:49

**Task 4(I2):**

Used only key words in beginning

Refined key words based on results received

Noticed the facets again:

Comment: “Hmm, what is this?”

**Time:** 5:45

**Task 4(I1):**

- Used key word search only
- Refined key words based on results
- Selected papers only from the first results page

**Time:** 4:30

**User 10**

Observation: User was very calm and took her time to explore the interface and the results.

Observation: Used commas to separate the key words

Observation: Did not use the paging navigation but she noticed it

Comment: Really enjoys research and found this study fun because there was no pressure

Comment: I noticed I'm getting better with it. Takes me less time to find resources. (learning)

**Task 1 (I2):**

- Started with key word search “Building safety measures”
- Refined the key words based on the results
- Looked at the “Field of study” facet
- Clicked “back” to return to the previous facet results
- Refined the key words again
- Explored the facets
- Interesting: used commas to separate the key words
- Refined the key word search and clicked on a “Field of study” facet again

**Time:** 7:51

**Task 1(I1):**

- Started with key word search but immediately started using the “Field of study” facet
- Kept on using the “Field of study” facet and explored the results

**Time:** 5:04

**Task 2(I2):**

- Started with a key word search
- Next explored the “Field of study” facet
- Refined the results with “Field of study” facet
- Conducted new key word search
- Refined the key words again

Selected results from the results list  
 Did a new key word search  
 Selected a “Field of study” option and explored the results  
 Drilled down into the “Field of study” then explored the results  
 Used key word search (comma separated)  
 Selected another “Field of study” option  
 Selected “Resource type” facet option

**Time:** 15:37

#### **Task 2(I1):**

Comment: likes the radio buttons, likes clicking on them  
 Started with a key word search but immediately selected “Field of study”  
 Refined the key word search  
 Explored the facets again  
 Explored the “Field of study” facet and narrowed the results  
 Tried new key words and refined them based on resulting facets and search results

**Time:** 11:49

#### **Task 3(I1):**

Started with key word search  
 Immediately took advantage of the “Field of study” facet and selected an option  
 Used the “Rseource type” facets to only view articles in the result set  
 Explored more of the “Resource type” and “Field of study” facets  
 Informed her choices of topics from the results  
 Continued selecting “Field of study” facet options

**Time:** 6:11

#### **Task 3(I2):**

Started with key word search  
 Explored the “Field of study” facet which informed her next key word search  
 Selected a “Field of study” facet option after refining the key words  
 Started with a key word search for the second topic  
 Immediately started exploring and selecting a “Field of study” facet option

**Time:** 4:38

#### **Task 4(I1):**

Starts with key words (comma separated)  
 Immediately selected “Field of study” facet option to inform her topic  
 For topic 1, initiated another key word search and found satisfying results  
 Continued collecting papers by selecting “Field of study”  
 For the second topic, started with key words  
 Explored the “Field of study” facet  
 Informed the topic from the results  
 Selected several papers from the results set  
 Explored more of the “Field of study” facet  
 Tried new key words

**Time:** 11:38

#### **Task 4(I2):**

Started with a wide topic range as key word: “genetics”  
 Then explored the facets  
 Informed a new key word search from “Field of study” facet  
 After some consideration, decided she did not like the topic and tried a new key word search  
 Selected articles from initial result set  
 For topic 2, started with key words  
 Informed the topic selection based on the result set  
 Selected papers from the initial result set

**Time:** 8:53

#### **User 11**

Question/Comment: Where would you expect to see the “saved” resources?

Somewhere around the top

Comment: Typically would formulate the topic before finding the papers but since I am unfamiliar with the topic, I write the topic after finding papers.

Comment: If he knew where the articles were saved and if they are saved, he would not copy and paste the results but find them later.

Comment: expected to see breadcrumb-style navigation for I2

Comment: Titles lose space between words (limitation)

Comment: Add row striping when a save check is selected

Overall comments on system:

Liked the linked navigation (traditional) better. Likes that the links don't give him an option but just drill down into the topic.

The radio buttons made him feel limited. He was expecting to be able to combine check boxes instead of just selecting one option.

Would have liked to see a breadcrumb or filter like that

**Task 1(I1):**

Started with a key word search

Used the paging navigation to see more of the results

Used only the result set to inform the topics

**Time:** 3:00

**Task 1(I2):**

Started with key word search

Explored the facets ("Field of study") to narrow down the topic

Used the "back" to unfilter the results

Used the "Field of study" facet again to find second topic

**Time:** 4:48

**Task 2(I1):**

For topic 1, Started with key word search

Used used "Resource type" facet to narrow down to articles only

Used the paging navigation to move to the next part of the result set

Realized "more" link reveals more of the facet collection

Expected to find a way to get back to the saved results (limitation)

For topic 2, started from home page with key words

Narrowed down the results by resource and "Field of study"

**Time:** 8:03

**Task 2(I2):**

For topic 1, started from the home page with key words search

Narrowed down the results by "Resource type" facet "article" and "Field of study"

Selected papers from the result set

Reversed the filtering of the results by using new key word search

Chose another option from the "Field of study" option and drilled down into it

**Time:** 5:28

**Task 3(I2):**

- Started with key words search on the home page
- Filtered results using “Field of study” facet
- Informed topics from the result set
- Used paging navigation to explore more of the result set

**Time:** 3:30

**Task 3(I1):**

- Started the search from home page using key words
- Selected “Field of study” option
- Informed the topics from the results

**Time:** 2:18

**Task 4(I2):**

- For topic 1, started from the home page using key word search
- Used “Resource type” to narrow down to “books” only
- Selected the first 3 resources from the result set
- Formulated topic after finding papers
- For topic 2, started from home with key word search
- Narrowed down the result set by “Resource type” “articles”
- Selected articles from initial result set
- Refined the key word search

**Time:** 7:07

**Task 4(I1):**

- For topic 1, started from home page with key words search
- Selected “books” from “Resource type”
- Selected resources from filtered result set
- For topic 2, did a general search with only “genetics”
- Used the “Field of study” facet

Comment: I will do a general search and narrow it down

- Selected papers from the result set

**Time:** 4:03

## User 12

Comment: I don't see the differences between these two interfaces

Comment: Interface 1 provided too broad categories, while Interface 2 was more specific and allowed her to drill into the categories

Comment: I learned while I went along

Overall comment on interaction: Liked the linked facet navigation (traditional) more. She prefers to click on links rather than radio buttons

### Task 1(I2):

Started with key word search (comma separated)

Analyzed the article results

Noticed the facets and selected an option from “Field of study”

**Time:** 4:30

### Task 1(I1):

Started with key word search

Analyzed the results and picked from the result set

Explored the facets and then the results

**Time:** 2:54

### Task 2(I2):

For topic 1, started with key word search: “Balck Holes, Matter”

Analyzed the results

Selected “Field of study” option

Clicked the “back” button to unfilter

Submitted a key word search query again

Comment: Results are confusing, it is like being in a library

For topic 2, started with selecting one of the options from “Field of study” facet

Analyzed the results

Selected resources from the result set

**Time:** 18:39

### Task 2(I1):

For topic 1, started with key word search: “Black Holes, Matter”

Picked topics from initial results

Used another key word search: “Gravitational wave astronomy”

Selected “Field of study” facet: “Gravitational waves”

Analyzed the results and picked an article and author

For topic 2, started with key word search: “Acceleration of particles by black holes”

Analyzed the results and picked articles from the result set

**Time:** 8:31

#### **Task 3(I1):**

For topic 1, started with key word search: “Energy, sustainability”

Refined the key word search: “Global energy, sustainability”

Analyzed the results and picked topics from the result set

**Time:** 4:45

#### **Task 3(I2):**

Started with key word search: “Global energy, sustainability”

Selected “Field of study” facet

Analyzed the results

Clicked the “back” button to return to the previous result set and facet options

Selected the “Collection” facet

Analyzed the results

Conducted another key word search: “Energy”

Explored the “Field of study” facet

Selected one of the facet options, explored the results, and picked topics

**Time:** 4:26

#### **Task 4(I1) – case study, detailed:**

Started with key word search: “Genetics and Animal Health”

Analyzed the results

Refined the key word search: “Genetics Animal Health”

Analyzed the results and picked topics

Selected “Animal genetics” from “Field of study” facet

Analyzed the results and picked papers

Selected “Health sciences” from “Field of study”

Selected an author “Smith, Rod” from “Author” facet

Analyzed the results and picked an article

Selected “News articles” from “Resource type” facet

For topic 2, started with key words search: “Genetics, Chemistry”

Selected “Chemistry” from “Field of study”

Analyzed the results

Selected “One File (GALE)” option from “Collection” facet

Analyzed the results

Selected “Articles” from “Resource type” facet

Analyzed the results

**Time:** 15:00

**Task 4(I2):**

For topic 1, started with key word search: “Genetics and computer science”

Analyzed the results

Selected “Computational Biology” from “Field of study” facet

Analyzed the results and picked both a topic and a paper

Refined the key words search: “Phylogenetic Analysis”

Analyzed the results, picked an article and an author

Clicked the “back” button to unfilter

Conducted another key word search: “Prokaryotic genes”

Analyzed the results and picked papers

**Time:** 7:51

## APPENDIX 8. IRB APPROVAL LETTER

**IOWA STATE UNIVERSITY**  
OF SCIENCE AND TECHNOLOGY

Institutional Review Board  
Office for Responsible Research  
Vice President for Research  
1138 Pearson Hall  
Ames, Iowa 50011-2207  
515 294-4566  
FAX 515 294-4267

**Date:** 2/18/2013      **To:** Stefan Ganchev  
509 N Hyland #2  
Ames, IA 50014      **CC:** Dr. Sunghyun Kang  
282 Design  
  
**From:** Office for Responsible Research  
  
**Title:** Prototype Evaluation  
  
**IRB ID:** 12-588  
  
**Approval Date:** 2/15/2013      **Date for Continuing Review:** 12/10/2014  
**Submission Type:** Modification      **Review Type:** Expedited

The project referenced above has received approval from the Institutional Review Board (IRB) at Iowa State University according to the dates shown above. Please refer to the IRB ID number shown above in all correspondence regarding this study.

To ensure compliance with federal regulations (45 CFR 46 & 21 CFR 56), please be sure to:

- Use only the approved study materials in your research, including the recruitment materials and informed consent documents that have the IRB approval stamp.
- Retain signed informed consent documents for 3 years after the close of the study, when documented consent is required.
- Obtain IRB approval prior to implementing any changes to the study by submitting a Modification Form for Non-Exempt Research or Amendment for Personnel Changes form, as necessary.
- Immediately inform the IRB of (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.
- Stop all research activity if IRB approval lapses, unless continuation is necessary to prevent harm to research participants. Research activity can resume once IRB approval is reestablished.
- Complete a new continuing review form at least three to four weeks prior to the date for continuing review as noted above to provide sufficient time for the IRB to review and approve continuation of the study. We will send a courtesy reminder as this date approaches.

Please be aware that IRB approval means that you have met the requirements of federal regulations and ISU policies governing human subjects research. Approval from other entities may also be needed. For example, access to data from private records (e.g. student, medical, or employment records, etc.) that are protected by FERPA, HIPAA, or other confidentiality policies requires permission from the holders of those records. Similarly, for research conducted in institutions other than ISU (e.g., schools, other colleges or universities, medical facilities, companies, etc.), investigators must obtain permission from the institution(s) as required by their policies. IRB approval in no way implies or guarantees that permission from these other entities will be granted.

Upon completion of the project, please submit a Project Closure Form to the Office for Responsible Research, 1138 Pearson Hall, to officially close the project.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or [IRB@iastate.edu](mailto:IRB@iastate.edu).

## APPENDIX 9. LETTER OF CONSENT

### **INFORMED CONSENT DOCUMENT**

**Title of Study:** Prototype Evaluation

**Investigators:**

*Principal Investigator:* Stefan Ganchev ([sganchev@iastate.edu](mailto:sganchev@iastate.edu))

*Co-Investigator:* Sunghyun Kang ([shrkang@iastate.edu](mailto:shrkang@iastate.edu))

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

### **INTRODUCTION**

The purpose of this study is to assess and compare the usability of 2 journal article search interfaces. You are being invited to participate in this study because you are a student and have responded to the solicitation for participation. You should not participate if you are under the age of 18 and are not currently a student at ISU.

### **DESCRIPTION OF PROCEDURES**

If you agree to participate, you will be asked to complete a brief survey about your use of library online resources and search engines. After completion of the survey, you will be asked to complete a series of tasks on 2 different interface systems. During the interface testing, you will be observed by the Principal Investigator, video will be captured of the screen activity (your identity and facial expression will not be recorded, in addition to your identity being kept confidential), mouse movements will be tracked and audio of your voice will be recorded. After completing the task sequence with the two systems, an exit survey will be conducted to collect feedback about your overall experience and to learn how you compare the two systems.

You are NOT required to answer any questions that you do not want to answer.

Your participation will last for a single session of approximately ONE HOUR.

### **RISKS**

There are no foreseeable risks at this time from participating in this study as compared to normal daily activity.

## BENEFITS

If you decide to participate in this study there will be no direct benefit to you. It is hoped that the information gained in this study will benefit society by showing ways to improve library search interaction for journal article search and the overall experience of students. It may also show how to improve information retrieval of academic content.

## COSTS AND COMPENSATION

You will not have any costs from participating in this study. You will not be compensated for participating in this study.

## PARTICIPANT RIGHTS

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled. You can skip any questions that you do not wish to answer.

## CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies auditing departments of Iowa State University, and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, the following measures will be taken: Only the principal investigator and co-investigator will have access to the data. Paper-based documents containing data from the research will be kept confidential in a locked filing cabinet, the video recordings, interview transcripts, and related data files will be kept as password protected computer files. The raw data and forms will be destroyed after it is transcribed and entered into a data management software. Participants' true identity will be protected in all reports and/or publications by using pseudonyms and fictional aspects. If the results are published, your identity will remain confidential.

**QUESTIONS OR PROBLEMS**

You are encouraged to ask questions at any time during this study.

- For further information about the study contact Stefan Ganchev, 515-326-2305, [sganchev@iastate.edu](mailto:sganchev@iastate.edu) or Sunghyun Kang, [shrkang@iastate.edu](mailto:shrkang@iastate.edu)
- If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, [IRB@iastate.edu](mailto:IRB@iastate.edu), or Director, (515) 294-3115, Office for Responsible Research, Iowa State University, Ames, Iowa 50011.

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**PARTICIPANT SIGNATURE**

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document, and that your questions have been satisfactorily answered. You will receive a copy of the written informed consent prior to your participation in the study.

Participant's Name (printed) \_\_\_\_\_

\_\_\_\_\_ (Participant's Signature)

\_\_\_\_\_ (Date)

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