Abigail M. Wickes. Challenges in Image Cataloging: A Case Study of the Image Database at the North Carolina Biotechnology Center. A Master's Paper for the M.S. in L.S degree. Mach, 2012. 51 pages. Advisor: Bradley Hemminger

This paper reviews some challenges of image cataloging, in the form of a literature review and a usability study conducted on the image database at North Carolina Biotechnology Center, hosted on Presto Inmagic software. The usability study aims to examine whether the addition of descriptive metadata detailing the conceptual aspects of images, e.g. the images' Aboutness, has a positive effect on users' searching experience while they conduct a series of assigned searching tasks designed to generate queries that require searching for images whose subject can be considered both general and abstract. In addition to this research question, the database design and existing description are examined for effectiveness.

Headings:

Cataloging of pictures

Searching behavior

Database searching

Image databases

CHALLENGES IN IMAGE CATALOGING: A CASE STUDY OF THE IMAGE DATABASE AT THE NORTH CAROLINA BIOTECHNOLOGY CENTER

by
Abigail M. Wickes

A Master's paper submitted to the faculty
of the School of Information and Library Science
of the University of North Carolina at Chapel Hill
in partial fulfillment of the requirements
for the degree of Master of Science in
Library Science.

Chapel Hill, North Carolina

March 2012

Approved by

_____

Bradley Hemminger

Contents

1.0 INTRODUCTION

The field of image cataloging and categorization presents many unique challenges. Unlike a book, an image does not offer any intrinsic information as to its creator or creation date, and while some subject analysis may be gleaned from viewing the image, images can hold abstract meaning that is not apparent merely through viewing. Even after assigning subject terms, the cataloger must consider whether the terms associated with an image will be consistent with users' search terms. The usability of an image database's interface will also affect users' searching success. The sheer quantity of images produced in the digital age only adds to these existing challenges. Attempts to surmount the task of organizing and annotating this growing number of images have included innovations and developments in manual and automatic processing techniques, based both on the content and concept inherent within an image. All methods have their own unique pros and cons.

This paper will provide a literature review describing the challenges of image cataloging for both front and back-end users, as well as advances in cataloging theory, techniques, and technology functions, and interface design related to solving these problems. These attributes and approaches will then be compared to the data obtained via research conducted on the usability of the image database at the North Carolina Biotechnology Center. Based on the literature review and research findings, short-term and long-term suggestions for improvement and further research will then be presented.

2.0 - LITERATURE REVIEW

2.1 - General Challenges

That the number of images now available is more vast than at any previous time in history, and that every day the quantity continues to grow, is a fact acknowledged at the forefront of many critical studies related to image cataloging (Hastings, 1999; Jaimes, 2000; Rui, 1999; Shen, 2008). This growth coincides ongoing trends of relying on high quality images to do much of the footwork in marketing and advertising, making adequate organization and access of image collections crucially important for a wide variety of holding agencies. Eakins and Graham (2000) state,

> ...the twentieth century has witnessed unparalleled growth in the number, availability, and importance of images in all walks of life. Images now play a crucial role in fields as diverse as medicine, journalism, advertising, design, education, and entertainment. (p. 6)

A thoughtfully chosen image can convey any number of themes much more instantly and memorably than a block of text, however it is this potential to convey multiple meanings that is at the heart of many of the challenges associated with cataloging an image collection.

Some challenges related to image cataloging have existed since before the digital era. Besser, in a 1990 article, discusses the lack of inherent information contained in an image, as compared to a book. He explains,

> …most books are written with clearly defined purposes in mind, and catalogers can expect that most potential users of these books will approach them from that standpoint. ...Unlike a book, an image makes no attempt to tell us what it is about. (Besser, 1990 p. 788)

In other words, image catalogers do not have the benefit of information commonly found on a book's title page or verso, including a statement of responsibility, copyright date, or title. This information is sometimes associated with images, but its presence is not guaranteed. To take this analogy further, catalogers of books and other more traditional library materials also have the advantage of aggregate record sources from which copy catalog records may be derived, such as OCLC Connexion. There is no such aggregate resource for image catalogers, so all records are by default original and created manually. Fully describing all aspects of an image for optimal access is a valuable but time-consuming process (Enser, 2000).

Part of this process is the complex act of generating subject analysis for an image. It is important to consider the fact that a given image may have a variety of potential uses for different users, beyond what the photographer, artist, or designer had considered when the image was created. Jörgensen describes this as a conflict between the need to preserve the uniqueness of an image while still providing enough description to allow many points of access (1998).

To illustrate this point further, Besser provides the example of a historic image of a crowded city scene, which would have differing elements of interest for the sociologists, architects, or costume designers of today, and certainly beyond the scope of what the photographer originally intended to capture (1990). Christel (2005) points out that users "often disagree on the relevance of a feature to a particular topic", making the task of subject analysis incredibly difficult, depending on the homogeneity of a user population. There is a large amount of information present in a single image, and the

cataloger must decide what level of description will provide optimal access for the needs of their user population (Jaimes, 2000).

2.2 - Description of Images

Panofsky's 1972 paper is a seminal work on image subject analysis. Although his work is from the perspective of an art historian, his theory to describe the levels of meaning in images can be applied across many different disciplines. To discuss the meanings of images, Panofsky breaks them into three levels: pre-iconography, iconography, and iconology. Pre-iconography is defined as primary or natural subject matter, which is then further divided into factual and expressional categories (Panofsky, 1972; Shatford, 1986). In other words, primary subject matter can be interpreted as what an image conveys in a straightforward way when it is viewed (factual) and what kind of mood is evoked by the viewing of an image (expressional). Iconography is a level of meaning which requires an understanding of the culture and background from which the image comes, so that subtle nuances contained within an image can be correctly interpreted. Iconology is the third level of meaning which gets at the inherent meaning of an image, evoking an encompassing feeling. This level of meaning is particularly difficult to include in description (Shatford, 1986).

Shatford's 1986 article, “Analyzing the Subject of a Picture” is another seminal work in image subject analysis. The article develops upon Panofsky's distinctions and proposes to make a more binary descriptive distinction with the terms “Ofness” and “Aboutness”. Attributes of Ofness are based on what information can be gathered by looking at the photo, and can be further delineated into the “Generic Of” and the “Specific Of”. A picture of birds could have the generic of quality of being of birds or

Figure 1: "Migrant Mother" by Dorothea Lange, 1936

even more broadly of animals, whereas the specific of quality would specify these birds as a variety of wren, or even more specifically provide their scientific name. These would be considered factual aspects according to Panofsky's theory of image description.

Aboutness describes more abstract qualities of an image that cannot be gleaned merely by looking at it or having existing knowledge of the subject matter, similar to Panofsky's expressional aspects. A helpful example provided by Shatford is Dorothea Lange's iconic image "Migrant Mother" (see Figure 1). The picture is *generically of* a woman and a child, *specifically of* Florence Thompson and her child, but could potentially represent, symbolize, or be *about* iconic concepts of poverty, resiliency, a mother's love, or The Great Depression. Aboutness terminology addresses the conceptual, abstract qualities of an image. While analyzing the Aboutness of an image is bound to be somewhat culturally subjective, it can be a highly sought after access point by users searching an image collection. Shatford also articulates concern on the potential limitations of assigning terms to images, asking whether image catalogers "...should run the risk of limiting empathetic reactions by codifying them", and if "the advantages of providing access to pictures based on their expressional content outweigh this risk" (Shatford, 1986, p. 43). However, as Schaffner says in a 2009 study on metadata in archives and special collections, "...librarians have often focused on what collections are made up of ... while many users prefer to learn what collections are about" (Schaffner, 2009 p. 6).

Catalogers' ability to apply a broad enough span of attributes in image description to cover all facets that might provide access to searchers is a tenet of Jörgensen's 1998 article. In order to discuss these facets clearly, Jörgensen divides potential image attributes into categories of Perceptual, Interpretive, and Reactive. Perceptual refers to attributes related to the physical content of an image (i.e. information that can be understood merely by looking at an image), and Interpretive refers to attributes which can also be gathered perceptually but require additional intellectual knowledge for further understanding (i.e. information that can be understood by looking at an image and also having enough background knowledge to recognize that some perceptual detail indicates a further level of specificity). Reactive refers to attributes within an image that create some kind of personal, emotional response.

Jörgensen's Perceptual and Interpretive attributes are very similar to Shatford's Generic and Specific Of, and it is also easy to see parallels between Shatford's Aboutness and Jörgensen's Reactive attribute. To continue with the example of "Migrant Mother", Jörgensen's Perceptual attributes would describe the image as of a woman and child, Interpretive attributes would specify the image further as of Florence Thompson, in a photograph by Dorothea Lange, and Reactive attributes could include description that indicates the photo depicts sorrow, desperation, resilience, or any terminology that conveys the emotional aspects of the image.

Eakins and Graham (2000) present another way to describe images in their delineation which includes Primitive features, Logical features, and Abstract attributes. Content is addressed in Primitive features—texture, color, and shape are among the many content-based features that can fall within this category. An example of Primitive features

related to “Migrant Mother” could include the fact that is black and white. Logical features convey information about the identity of objects shown (similar to the Generic and Specific Ofness of Shatford's research, and the Perceptual and Interpretive Attributes of Jörgensen). Abstract attributes are also similar to Shatford's Aboutness and Jörgensen's Reactive attribute, in that they categorize terminology related to the significance of what is depicted in an image, rather than the visual elements of an image.

Stemming from Panofsky's, Shatford's, and Jörgensen's theories on categorization of image description, Enser (2003) provides further categories for describing images:

- Documentary—General Purpose
- Documentary—Special Purpose
- Creative
- Model

Documentary general purpose type images can also be described as “faithful representations of reality” which are designed to be reproductions of actual things or “a momentary entrapment of reality” (Enser 2003). Documentary Special Purpose type images are also reproductions of actual things, however the subject is only apparent with special knowledge or equipment (such as an ultrasound scan). The Creative type is a broad category which can include everything from documentary images which have been altered in some way, to abstract artwork. Models are images that depict processes or phenomena, such as blueprints or maps.

These categories are much broader than those described previously, and it is clear that they cover gray area. “Migrant Mother”, for example, could be placed into “Documentary—General Purpose” for faithfully depicting a woman and a child as they were seen in real life, but it could also fall into “Creative” as an evocative piece of artful photography. It also becomes increasingly difficult to draw the line between

Documentary and Creative in this era of digital editing software, when an image that began as a Documentary type can be fixed and modified by a skilled professional to the point where it could arguably also be placed in the Creative type.

2.3 - Searching for Images

Along with the myriad ways to approach the challenge of image description, understanding the searching needs and habits of your users is also important to ensure adequate access. In addition to description categories, Enser also suggests considering users according to Generalist and Specialist categories within the image types of Documentaries, Creative, and Model (2003). However, the problematic broadness of Enser's image types extends into the broadness of these searcher types.

Here is an example to illustrate the issues within such broad categorizations. If a hypothetical searcher was looking for images of birds, a searcher whom Enser would call a Documentary General Generalist might simply choose to use the search term “bird” or slightly more specifically, “wren”, whereas a Documentary General Specialist could use terms related to the scientific name. A Model Specialist might be looking to find an illustration or model of bird anatomy, but this is a query that could be of equal interest to a Documentary Special Purpose Specialist. A Creative Generalist or Specialist could choose to search “Audobon birds”, looking for Audobon's famous artistic renditions, but since these creative images are also so true to life, they could also be the target of a searcher looking for Documentary type images. Since these categories cannot be relied upon to provide evidence of distinct searching needs, it is hard to say why it is worthwhile to spend time categorizing users in such a way.

With these issues in mind, it may be more useful and efficient for image catalogers to consider categorizing search queries into levels of specificity, rather than the searchers themselves. Armitage (1997) delineates queries according to the following categories:

- Image Content
- Identification/Attribution/Provenance Checking
- Accessibility of Image
- Miscellaneous

In other words, queries for images can be considered in regard to information which can be obtained by viewing the image (e.g. content), information regarding who owns the rights to the image and how these should be acknowledged (e.g. identification and attribution), and information regarding how the user may view and obtain the image (e.g. access) with all other queries falling into the miscellaneous category.

Jörgensen also categorizes queries according to a searcher's intent. These categories include:

- Request for a specific item (e.g. an official White House photo of President Jimmy Carter)
- Request for a specific instance of a general category (e.g. any campaign photo of Jimmy Carter)
- Request for a general topical or subject category of images (e.g. Presidents of the United States)
- Requests for images communicating a particular abstract concept or affective response (e.g. photographs of world leaders representing power) (Jörgensen, 2005, p. 1347)

Analyzing queries according to this characterization will also implicitly provide information as to how familiar users are with a photo collection, in that a preponderance of requests for a specific item or category could indicate that users have browsed the collection often enough to know what it should hold.

It can also be helpful to categorize formulated queries in terms of the success and failure of these queries. Hastings' 1999 article characterizes problems within formulated image queries according to Technical, Semantic, Content, and Relativity issues. Technical issues cover problems having to do with size or resolution of image files, as well as load time, band-width, and other technical aspects that may cause image failure. Semantic, or concept-based issues deal with retrieval problems having to do with the terminology associated with an image. (These include issues described in greater detail in the "Description of Images" section of this paper). Content issues describe retrieval problems in terms of what Eakins and Graham described as images' Primitive Features, including the ability to retrieve based on color, texture, or shape featured in an image (Eakins & Graham, 2000). Finally, Relativity issues describe whether retrieved images are accurate according to Shatford's Aboutness attribute—whether they are conceptually and thematically relevant to what the user was searching for.

By analyzing what aspects of logged queries contributed to failure, catalogers can assess image description so it can better suit the needs of their searching population. The downside to this tactic is that it does require access to logged queries, which is a feature that is not universally available. However, if queries can be accessed they can contribute valuable information on how users interact with existing description and how description may be altered to contribute to a higher level of searching success.

Along with analyzing logged queries, the interface with which users engage can also determine the success or failure of their searches. Principles that apply to basic web design are also applicable to the design of digital database interfaces. As Jörgensen puts it "...it is a well-known phenomenon that users often express an information need in terms

of the way they think the system can handle it, rather than of what they really need (Jörgensen, 2005, p. 1347).

2.4 - Optimal Design

Studies making use of eye tracking visualizations have shown that internet users tend to view webpage content in an 'F' shaped pattern, in that they begin viewing a page's upper horizontal movement, trail off after several lines of horizontal content, and continue down the page by vertically scanning the left-hand portion (Nielsen, 2006). What this means for interface design is that all content on a page is not fully absorbed, and that the most important areas of description should be within the first section of a database page. Another strategy to combat users' tendency to quickly scan beyond the first section of a page is to start subsequent description sections with information carrying words users will notice as they vertically scan.

The tendency to pay less attention to information while progressing down a webpage is reiterated in the "above the fold" phenomenon (Nielsen, 2010). Above the fold refers to content that can be immediately viewed by users without having to scroll down to content hidden from view by the parameters of the screen. This principle again shows the importance of keeping the descriptive information that is most relevant to your user population towards the top of a webpage, since it is unlikely users will take the time to scroll down and see what else is available to them. These design principles may be applied to advanced search screens, results screens, and screens for individual image records within an image collection database.

Another important component of good design is addressing whether or not your page is accessible to users with varying disabilities. Creating an ADA compliant page is

an involved process, but there are several key areas which should be covered when presenting text and images for searching, according to a report by Jakob Nielsen:

- Choose text colors for good contrast.
- Do not use very small text for body text.
- Do not use small or subtle text headings and categories.
- Always create good contrast between text and the page background.
- ...
- Make sure it is possible to magnify your site.
- Write concisely, and remove superfluous text.
- ...
- Offer a search engine that is forgiving of spelling errors.
- ...
- Do not put the search box in an unlikely spot.
- Clearly describe search results.
- Inform users when they have entered nothing in the search query (Nielsen, 2001, p. 37).

The factors to determine usability should ideally be considered from the perspective of multiple disabilities; however, knowing the potential disabilities of your own user group is a good place to start when considering the usability of your own site. Understandable, intuitive design is particularly important for users interacting with advanced and unfamiliar retrieval software.

2.5 - Comparing Concept-based and Content-based Retrieval Software

Over the past few decades, software designed for housing and accessing digital image collections has typically been developed with a focus on either content-based or concept-based retrieval. Content-based retrieval draws information from what Eakins and Graham (2000) describe as Primitive features. This can include attributes of color, texture, or shape. Queries may be in the form of an initial image with desirable content attributes, and content-based retrieval software will gather and return images with similar content attributes. Concept-based (or semantic) retrieval is based on a verbal or textual

query which is matched against the verbal or textual description associated with an image (Enser 2000). There are advantages and disadvantages to each approach.

Development of content-based image retrieval software was especially prevalent in the 1990s, as the result of a surge of advancements in digital photography and software during that decade (Rui, 1999; Yu, 2012). An acute need existed for image retrieval programs that could provide speedy access to the ever-growing number of images, and because creating concept-based, semantic description of images is an incredibly time-consuming and inherently subjective process, a focus on automated content-based image retrieval emerged.

Content-based retrieval attempts to solve a theoretical problem shared in all image retrieval scenarios, specifically outlined in a case study at UC Berkley, that "descriptive text is usually inadequate for finding the precise visual image for which one is searching" (Besser, 1990). This point is also highlighted in a 1998 article by Jörgensen, which refers to the "hypothesized disjunction in cognitive modalities which arises from searching for visual media through text range" (Jörgensen, 1998, p. 163). In other words, it feels incongruous to use words to search for something that is not composed of text. By capturing and using information gathered from a surrogate image to browse for similar images, content-based image retrieval can ideally avoid this incongruity in a time-effective and objective manner.

In spite of these beneficial aspects of content-based image retrieval, a study by Eakins & Graham from 2000 has shown that it is only effective for lower level user queries and that most users demand higher levels of retrieval. Enser's study from the same year also showed a demand for concept-based rather than content-based image

retrieval, and several years later Hare et. al.'s 2007 study states an outright "shift away from the idea that content-based retrieval is the solution to all multimedia retrieval needs" (p. 250).

The main reason for this shift away from content-based image retrieval is the semantic gap, or the "lack of coincidence between the information that one can extract from the visual data and the interpretation of that same data for a user in a given situation" (Hare et. al., 2006, p. 75). In other words, relying on content-based data will not provide as detailed a level of specific or abstract information as semantic description described by Shatford's Specific Ofness and Aboutness, Jörgensen's Interpretive and Reactive attributes, or Eakins & Graham's Logical Features and Abstract Attributes can provide for users. As Hare et. al. go on to say, "the hallmark of a good image retrieval system is its ability to respond to queries posed by searchers, presented in the desired way" (Hare et. al., 2006, p. 78). With users demanding higher levels of search retrieval, content-based image retrieval may not be the promising option it once seemed to be (Eakins & Graham, 2000, p. 4).

The Flamenco Image Browser is a content-based image retrieval approach that is more customizable for users (Elliott, 2001). To search with this browser, a user selects one to three similar images, then moves them to a query section of the interface and asks the system to retrieve "more like this". The images that come up in the search results are grouped into four different categories, each corresponding with a different type of metadata related to the original group of images. This way the content-based retrieval can be manipulated until the results are relevant to the user.

Although the study examined a moving image collection, a 2004 paper by Yang et. al. provides an illustration of retrieval success with a hybrid concept-based and content-based system. Retrieval results showed that concept-based and the combined hybrid retrieval systems worked best for queries demanding high specificity, and all three systems did about the same for generic topics, noting that,

> ...concept-based indexing and retrieval methods have high expressive power, and thus might provide more accurate or precise results for more specific topics, such as proper nouns. (p. 370)

For high-level user needs however, the presence of textual, semantic searching was crucial for relevant results.

Recent research further examining the benefit of combining content-based and concept-based image retrieval aims to overcome one of the main disadvantages of semantic based retrieval—the amount of manual labor and time involved in creating semantic description. A 2008 paper by Shen and a 2012 paper by Yu describe similar studies which aim to bridge the semantic gap with systems that learn semantic description from neighborhoods of content and concept in similar images provided by an end-user. Further semantic description is then auto-annotated in related images. Stoica & Hearst describe a "nearly-automated" way to create metadata hierarchies in their 2004 paper, which proposes to take hierarchies of synonyms from the WordNet lexical system, diagram them into related trees, and then remove the broadest and least relevant terms. In this way semantic content is auto-generated but also refined by an information specialist.

Auto-annotation does have some disadvantages, however. Yu (2012) provides the example of an image of a skyscraper to illustrate one drawback, in that if the original image provided by an end-user is of a skyscraper with semantic information including

“New York City” and content-similar images include skyscrapers that are not in New York City, the auto-annotated semantic information will be incorrect. This mistake would be difficult to detect in a large image collection, and its presence would be exponentially detrimental to retrieval success of the single image as well as other neighborhood images whose semantic information continued to be auto-annotated incorrectly.

Auto-annotation seems to already be a viable option for description encompassing the Generic Ofness of an image, but further levels of specificity seem more vulnerable to error. At this point, unfortunately, advanced content-based retrieval software is not within the budgetary reach of many smaller institutions' image collections. The collection included in this study's research is housed on software whose retrieval is solely concept-based.

3.0 RESEARCH

3.1 - Introduction

After gaining an understanding of the challenges in image cataloging from both the perspective of a cataloger and an end-user, this knowledge was put to the test in a pilot usability case study of the image database at the North Carolina Biotechnology Center. NCBiotech is a state funded non-profit based in Research Triangle Park, NC, whose mission is "to provide long-term economic and societal benefits to North Carolina through support of biotechnology research, business, education and strategic policy statewide." (NCBC, 2012). As part of this mission, NCBiotech has a special library which provides employees (and outside researchers willing to pay a small fee) with access to databases, market research, books, journals, videos, and other resources. Among these databases is an online image database, hosted on Presto social knowledge software from the company Inmagic.

The Presto image database was created in Fall 2010 and currently holds nearly seven thousand image records. The collection includes images related to biotechnology in various sectors (such as agriculture, medical, research & development, etc.) as well as images from events held at NCBiotech (such as visits from government officials and international delegates, consortia for companies in biotechnology sectors, and employee appreciation events.) Many biotechnology companies also provide their own images to be archived and used for NCBiotech's purposes of marketing and promoting biotechnology. Although the Presto image database is available to all NCBiotech employees, it is a goal

of the library to research the usability of the image database in its current form, and to increase and facilitate use based on these observations. One way to try and achieve this goal is by supplementing existing metadata with terminology more closely related to the language used in each department, allowing for further access to the Aboutness aspects of the images.

At the start of this research, the database records' descriptions include terminology which could be described by Shatford's Generic and Specific Ofness, in that it details what and who can be seen where and when, but records' descriptions did not detail much in terms of Aboutness. In addition to gaining a better understanding of the usability of the database at current time, this research study proposed to assess whether the addition of description detailing Aboutness would have a positive effect on searcher's retrieval success.

3.2 - Methodology

Participants for this study were recruited via email listserv from NCBiotech's approximately eighty-five permanent, temporary, part-time, and full-time employees, from all six of the company office locations, (which include the main location in Research Triangle Park, as well as regional offices in Greenville, Charlotte, Winston-Salem, Wilmington, and Asheville, North Carolina) all of whom have access to the Library's resources.

The study hoped to gather twelve to twenty participants from this pool. As incentive, entry into a drawing for a fifty dollar cash gift card was offered to participants who completed both portions of the proposed research study within the designated time period. A total of seventeen participants agreed to take part in the research study,

however only twelve responses were received in the initial portion of the study and eleven responses were received in the secondary portion.

The research study consisted of two parts, each with two designated searching tasks and a follow-up survey. In the initial portion of the research, participants were emailed a link to the homepage of the Presto Image Database with instructions to complete searching tasks and a link to the follow-up survey. The first searching tasks were as follows:

1. Search for an image of trees.
2. Search for an image representing a business agreement.

The searching tasks aimed to cover Jörgensen's query categories of "Requests for general topical or subject category of images" and "Requests for images communicating a particular abstract concept or affective response", and will be referred to hereon as general and abstract searching tasks, respectively (Jörgensen, 2005, p. 1347).

In the secondary portion of the research, participants were emailed roughly two weeks later with a link to the image database homepage, two designated searching tasks, and a link to the follow-up survey. The second searching tasks were as follows:

1. Search for an image of algae.
2. Search for an image representing networking.

These searching tasks also aimed to cover the same categories described above; however, the second portion of the research featured the addition of a new descriptive subject field to the database, covering more abstract terminology related to the images' Aboutness. This additional field was labeled "Abstract Subject" and placed below an existing field labeled "General Subject". The abstract subject term "networking", which was

specifically asked for in the second searching task, was included in a controlled terminology list within the newly added field.

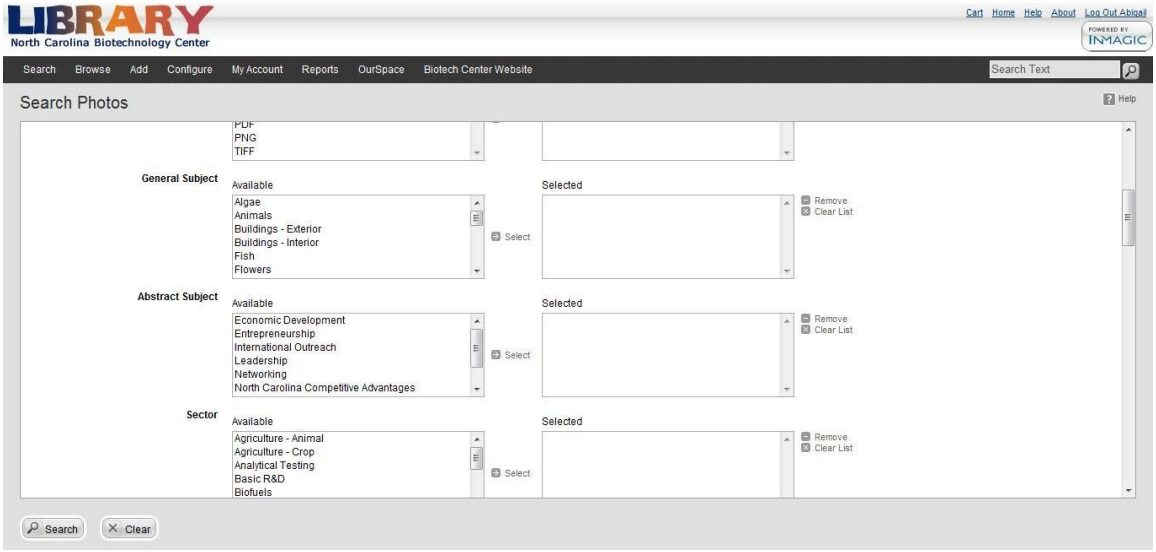

Figure 2: Screen shot of added "Abstract Subject" field.

3.3 - Hypothesis

The research question on which this study was designed was whether or not adding abstract subject description would have a positive effect on users ability to search for abstract concepts in the image database. Prior to examining the data gathered by the study, the following hypotheses were made in anticipation of the study results:

1. Most users will perform keyword searches rather than controlled vocabulary.
2. Users will express frustration at lack of robustness via keyword searching.
3. Users will have more difficulty with abstract searching task (second) than general (first) during the primary searching tasks.

4. Users will benefit from the presence of an Abstract Subject field when conducting the secondary abstract searching task.

The actual study results confirm and conflict with some of these hypotheses and leave others unanswered.

3.4 - Results

After completing each searching task in the initial and secondary searching tasks, users were asked the following question about each of the searching tasks:

"Please describe the steps you took when searching for images of _____ in the Presto database."

After coding the free text responses according to whether searchers used keyword search, controlled vocabulary search, or a combination of both, the following results were apparent:

Table 1: Keyword versus Controlled Vocabulary Search Strategies

Question: "Please describe the steps you took when searching for images of _____in the Presto Database."			
Searching Task 1			
(SUBJECT)	**KEYWORD**	**CONTROLLED VOCAB.**	**BOTH**
General: Trees	83%	17%	0%
Abstract: Business Partnership	67%	8%	25%
Searching Task 2			
(SUBJECT)	**KEYWORD**	**CONTROLLED VOCAB.**	**BOTH**
General: Algae	64%	36%	0%
Abstract: Networking	55%	27%	18%

When designing this question, the terms "trees" and "algae" were selected because they exist on the general subject search list and are descriptive terms that access the Ofness of

an image. The terms “business partnership” and “networking” were selected because they are terms that reflect an abstract concept, e.g. the Aboutness of an image. Both of these abstract Aboutness terms were included in the added “Abstract Subject” controlled vocabulary term list for Searching Task 2.

The results confirm the expectation that keyword search would be the most popular among users. They also show a tendency for users to gravitate towards controlled vocabulary searching both as time goes on and as searching tasks become more abstract. The following tables indicate users’ reported confidence levels when conducting the initial and secondary searching tasks:

Table 2: User Reported Success in Initial Searching Tasks

Question: “How would you describe this searching experience? Select any answers that apply.”			
Searching Task 1 – Subject “Trees		**Searching Task 1 – Subject “Business Partnership”**	
Answer	**%**	**Answer**	**%**
Successful	92%	**Successful**	83%
Unsuccessful	0%	**Unsuccessful**	0%
Easy to figure out	25%	**Easy to figure out**	25%
Confusing	17%	**Confusing**	0%
Too many results	33%	**Too many results**	17%
Too few results	0%	**Too few results**	33%
Easy to browse results	33%	**Easy to browse results**	25%
Difficult to browse results	0%	**Difficult to browse results**	0%

Table 3: User Reported Success in Secondary Searching Tasks

Question: "How would you describe this searching experience? Select any answers that apply."			
Searching Task 2 – Subject "Algae"		**Searching Task 2 – Subject "Networking"**	
Answer	**%**	**Answer**	**%**
Successful	100%	**Successful**	91%
Unsuccessful	0%	**Unsuccessful**	18%
Easy to figure out	45%	**Easy to figure out**	36%
Confusing	0%	**Confusing**	18%
Too many results	0%	**Too many results**	0%
Too few results	9%	**Too few results**	18%
Easy to browse results	55%	**Easy to browse results**	27%
Difficult to browse results	9%	**Difficult to browse results**	18%

All responses consistently show a high level of user reported success, in both the general and abstract tasks and both before and the addition of the Abstract Subject field. Reported success for the abstract searching tasks (e.g. business partnerships and networking) rose slightly in the second searching task, along with users reporting use of controlled vocabulary search strategies. .

It is interesting to note that all users unanimously reported a successful search for the second general searching task, (requiring a search for algae,) and there are several

ways this universally reported success can be interpreted. Since this was the secondary searching task, even new users would have an increased familiarity with the database and might therefore experience higher confidence levels. Additionally, since the subject terms are in alphabetical order, "Algae" is placed high on the list and was therefore easy for users to find. This was also a fairly straightforward searching task, so with the combination of increased exposure to the database and guaranteed results in with both keyword and controlled vocabulary searching strategies, it is not surprising that such an overwhelming success rate was reported.

As shown in Table 4 below, most of the participants did not notice the presence of the newly added Abstract Subject field during the secondary searching task. The table details responses to a question asking whether any changes to the image searching screen were perceived, and the responses were then coded according to whether the users noticed nothing, whether they noticed the new subject field, or other, when the user stated that they noticed a change which was not actually made.

Table 4: Perceived Changes among Participants

Question: "If you noticed any changes in the Presto image searching screen, please describe."	
Perceived Changes	**% Response**
No changes noticed	63%
Addition of Abstract Subject field noticed	25%
Other erroneous change perceived	12%

Since only eight of eleven participants responded to this question, it is possible that the three participants who neglected to respond also did not perceive any changes, and elected to leave the question blank since there was no perceived change to describe. If this assumption is true, the percentage of participants who did not notice any changes is

even higher. Data from the following question which all eleven participants answered further supports this assumption, as eight participants responded that they had not noticed any changes.

Table 5: Effect of Perceived Changes on Search

Question: "Please rate whether any perceived changes had an effect on your search. Select any statements that apply.	
Answer	**%**
I did not notice any changes.	73%
I noticed changes but did not use the new fields.	9%
Using the new fields made it easier to find useful results.	18%
Using the new fields did not seem to have any effect on my search results.	0%
Using the new fields was confusing.	9%
Using the new fields made searching easier.	9%
Using the new fields made searching more difficult.	0%
The new fields will make me more likely to use Presto for image searching.	9%

The fact that so few participants noticed the additional field could at surface level be interpreted as an indication that users are less willing to explore an interface with which they are unfamiliar, as the data also shows that most participants have not used the image database much before the study:

Table 6: Participants' Familiarity with Using Image Database

Question: "How often do you use the Presto image database? Select the answer which best applies."	
Answer	**% Response**
This is my first time using it.	17%
I've only used it a few times.	50%
I use it at least once a month.	17%
I use it at least once a week.	17%

It is also possible that the new field went unnoticed by so many because of the "below the fold" rule (Nielsen, 2010) pointed out in the literature review. As evidenced by a screen shot of the Search Photos page, the new field is well below the fold:

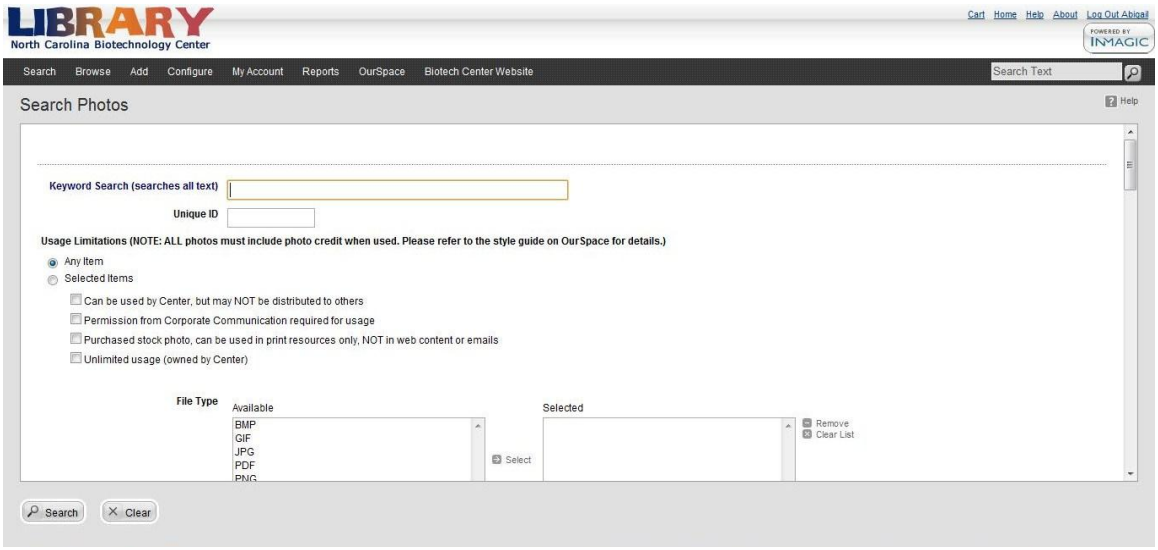

Figure 3: The Abstract Subject field is not immediately visible on the Search Photos page.

However, when the data from Table 1 is compared to the data from Tables 4 and 5, it is clear that more participants used the controlled vocabulary on the secondary abstract searching task than reported the recognition of the additional Abstract Subject field. Since there was such a highly reported success rate during the secondary abstract searching task, it is likely that users did in fact find the new field and did not recognize that it was not on the search page during their initial searching task. Several answers from the questions regarding the second abstract search seem to confirm this theory:

Question: "Please describe the steps you took when searching for images of "networking" in the Presto Image database."

> "I knew that the specific search categories can be better than keywords, so I scrolled down and looked under the subjects, saw Abstract Subjects, thought Networking would be a bit abstract, and looked for it there. What

> do ya know? Networking was a choice! Chose that and brought up plenty of wonderful images"
>
> "Search - photos - abstract subject – networking"
>
> "...to explore more options, I went back to search again and started scanning all of the predefined categories. I was pleasantly surprised to actually find "networking" under Abstract Subject so I cleared first, then selected it by itself and hit search."
>
> "Go to dropdown menu under "Search" and choose "Photo". Put "networking" into keyword search. Returned 58 images. Secondarily I selected "Networking" under the General Subjects tab. Returned fewer images."
>
> "…typed in networking into quick search box. got only 16 results. When selected networking from topic and searched, got slightly different selection of images, but not as many as I thought. I KNOW there are many events pics with networking in them."

These quotations show that even though 73% of participants reported not to have noticed any changes, 46% of participants used the Abstract Subject field without realizing it was only available for the secondary searching task.

The data also seems to show that users were more likely to use controlled vocabulary terms for abstract subject searches, as shown in Table 1. In the initial searching task, 33% of participants used either just controlled vocabulary search fields or a combination of controlled vocabulary and keyword search for the abstract task, to find an image representing a business partnership, compared to 17% who used controlled vocabulary to complete the general subject search of finding images of trees. In the secondary searching task, 46% of participants used either just controlled vocabulary search fields or a combination of controlled vocabulary and keyword search for the abstract task to find an image representing networking, compared to 27% of participants who used controlled vocabulary to complete the general subject search of finding images of algae. This correlation, along with the fact that 46% of participants used the new Abstract Subject field, could indicate that its presence is beneficial to searchers.

To return to the assumptions made before conducting the research, data on Table 1 and the included quotations regarding the secondary abstract subject task seem to confirm that users had more difficulty with the abstract searching task than the general. However, this is seems to be equally the case between the initial and secondary tasks. 25% of participants used both searching strategies—keyword and controlled vocabulary—to conduct the abstract searching task of finding images representing a business partnership, and 18% of participants used both searching strategies to conduct the abstract searching task of finding images representing networking. By comparison, 0% of participants using a combination of both searching strategies for the general searching tasks. The fact that users elected to use two search strategies seems to indicate a greater level of complexity of the task at hand; when the first strategy failed to yield beneficial results, a second strategy was employed. In many cases, the second strategy involved the use of the new Abstract Subject field.

While developing the study, the placement of the new Abstract Subject field was a difficult decision to make. Placing it front and center seemed inconsistent with the existing flow of Controlled Vocabulary fields, so it was decided that the Abstract Subject field should be placed below the General Subject field in order to acknowledge the relationships between the fields. Both the existing General Subjects field and the new Abstract Subjects field may have garnered greater use if they were placed towards the top of the Search Photos page.

Since these controlled vocabulary search fields offer more efficient searching for users as well as more time-efficient description for the cataloger, it is a long-term goal to increase the use of these fields among end-users. However, it should be noted again that

the majority of participants—most of whom elected to use keyword search—rated their searches as successful across all searching tasks (see Tables 2 and 3). The high levels of reported success were unexpected, since one of the assumptions made before the study was that users would express frustration with the image database's lack of robustness via keyword searching. This high success rate could be attributed to the fact that the search terms were essentially supplied within the searching tasks, whereas a user searching for their own needs may not be as sure about what terms will yield beneficial search results. While the decision to use keyword search could be the result of participants not realizing controlled vocabulary searches were an option—because they are new users, and because these fields are below the fold—but it could also more straightforwardly indicate that users are a bit more comfortable with keyword searches and will probably continue to use them, in spite of the presence of controlled vocabulary options.

4.0 – RECOMMENDED MODIFICATION AND FURTHER RESEARCH

4.1 - Recommended Modifications based on Research Data

Participants were asked directly how the database could be improved. The following table indicates their coded responses for both the initial and secondary searching tasks. “More images” indicates the participant would like a larger quantity of images to select from in the database. “Links” indicates the participant wishes the hyperlinks within the database were active. “Bigger images” indicates the participant would like to be able to access full size, high resolution versions of the images, and may be related to the problem of the hyperlinks not being active. “Semantics/Design” indicates the layout of the page was in some way confusing to the participant and/or the participant would like more information on the pages about what each field represents and means. “Mac friendly” indicates that the participant would like the program to work more easily with Mac computers (as opposed to Windows computers, which are what most employees of NCBiotech work from). “Nothing” indicates that the participant explicitly stated in some way that they could not think of any changes to be made.

Table 6: Participants' Familiarity with Using Image Database

Question: "What kinds of changes or improvements would make you more likely to use the Presto image database?"			
Initial Searching Task		**Secondary Searching Task**	
Answer	**% Response**	**Answer**	**% Response**
More images	18%	More images	0%
Links	18%	Links	20%
Bigger images	0%	Bigger images	30%
Semantics / Design	27%	Semantics / Design	20%
Mac friendly	10%	Mac friendly	10%
Nothing	27%	Nothing	20%

It should be noted that only eleven out of twelve participants responded to this question after the initial searching tasks, and only ten out of eleven participants responded after the secondary searching tasks. The lack of response from the remaining participants could indicate that they did not feel strongly about making any changes, but to avoid making incorrect assumptions only the recorded answers were taken into account.

It should also be noted that there was some cross-over between the complaints coded as "Links" and "Bigger photos". When the image database was first made available for employee use, each image record included one or more active hyperlinks so users could click through to the high-resolution, full-size image corresponding to the thumbnail image on the record:

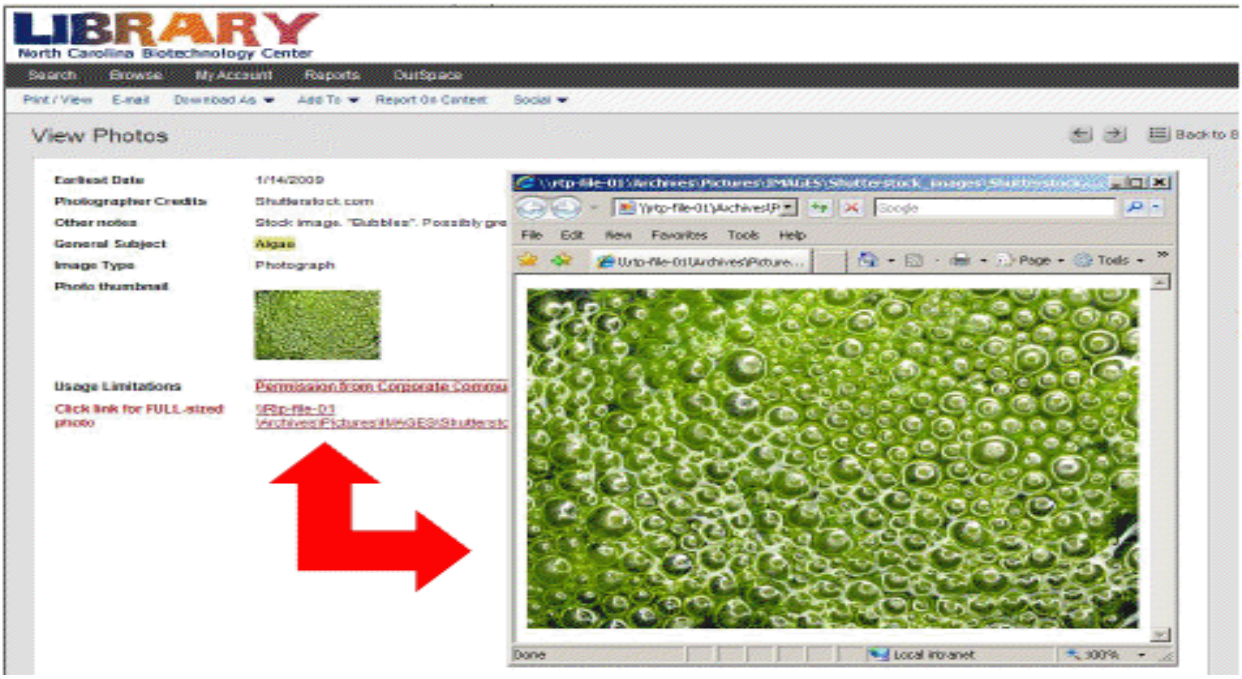

Figure 4: Active Hyperlink in Image Record

These links become inactive after a system upgrade, and the problem of reactivating them has been examined but has not yet been solved. At present users must copy and paste the file path into their browser window to access the full size, high resolution image files. It's difficult to say whether users indicating a desire for bigger images are referring to a desire for a larger thumbnail or the desire to access the full-sized images, since the process of accessing files has become much less convenient and intuitive with inactive links.

The prevalence of participants' desire for changes coded “Links” and “Bigger Images” could be solved a number of ways, if actually activating the links remains outside the scope of solutions. In some cases a record's hyperlink is not visible immediately from the first screen, since the field is towards the bottom of the page. Bringing this field to the top of the page might help users connect that this link is what

they need to use to access high resolution, larger images. There is currently a note associated with this field which reads “NOTE: links are not currently working, so please copy file-path into browser window to access full-size images”:

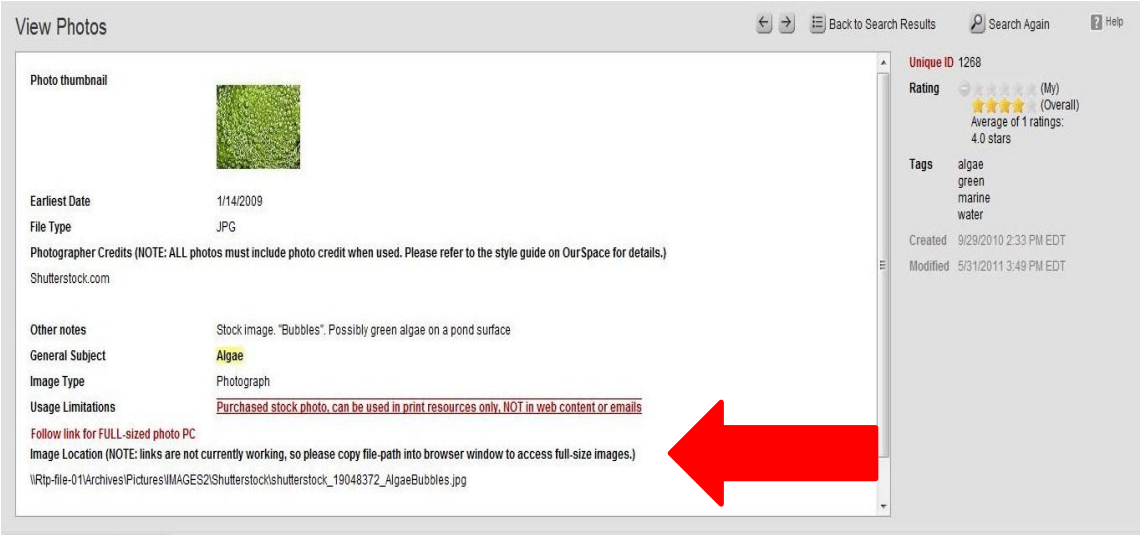

Figure 5: Note to Indicate Problem with Hyperlinks

Notes of this kind seemed to be appreciated by users, since participants requested more semantic information within the database interface. Adding more information about what fields do or links to searching procedures documents could also be beneficial for users. Several participants indicated this explicitly in their responses:

Question: “What kinds of changes or improvements would make you more likely to use the Presto image database?”

> “some additional navigation guides on the search screen, such as a 'submit' button (or did I miss it?). Perhaps an opening page with a 'welcome' message and basic description of the photo collection. although simple is great, there's no introductory information for the first time user.”
>
> “ Brief definitions of key terms on search screen ... or links to explanations housed elsewhere”
>
> “Adding 'submit' or 'go' buttons would be nice.”

The responses that indicate the desire for the addition of a button to push when searching are interesting, since there is a button labeled “Search” in the bottom left-hand corner of the Photos Search page (see Figure 3). The button is small and outside of the main area where users will input search terms. Since it is light gray, it does not contrast well with the light gray background against which it is set, making it easy for users to skip over when scanning the page. Adjusting the hue for a higher contrast would make this easier for users to find on the screen (Nielsen, 2001). The current positioning of the search button is also in direct opposition to Nielsen's compliancy mandate which states, “Do not put the search box in an unlikely spot” (Nielsen, 2001, p. 37). Placing the button in a more visible area of the screen would make it easier to find and reflect users' inclination to pay more attention to information in the top portion of a screen, according to the F shaped reading patterns observed by Nielsen (2006).

The “Help” feature is also difficult for users to find. As seen in Figure 4, it is an extremely small link in the top right hand corner of the screen, in a shade of darker gray that does not offer much contrast with its light gray background. Users' comments on the lack of Boolean searchability in the database seem to indicate that the Help button was not noticed:

Question: “What kinds of changes or improvements would make you more likely to use the Presto image database?”

> “Being able to select which boolean operators to use for the predefined categories might make it more useful. If there was a way to narrow results for predefined categories would be nice (sort of like a secondary search). I'm not sure if that is currently possible.”

The Help link will provide access to a document which explains how to incorporate Boolean search terms within a search, but it does not seem like any users were able to

find this help. In lieu of magnifying, coloring, and relocating the Help link so it is more prominent, (which would be an ideal solution but may not be immediately available from the software company) a note describing how to use the basic Boolean search functions might help users get further with the keyword search. A note directing users to the nearly invisible Help button could also be beneficial.

The suggestions in the participant's quotation above could also be mitigated by the presence of a more robust faceted search feature within the database. Users can currently narrow down search results with the use of a keyword filter located at the top right of the Search Results page:

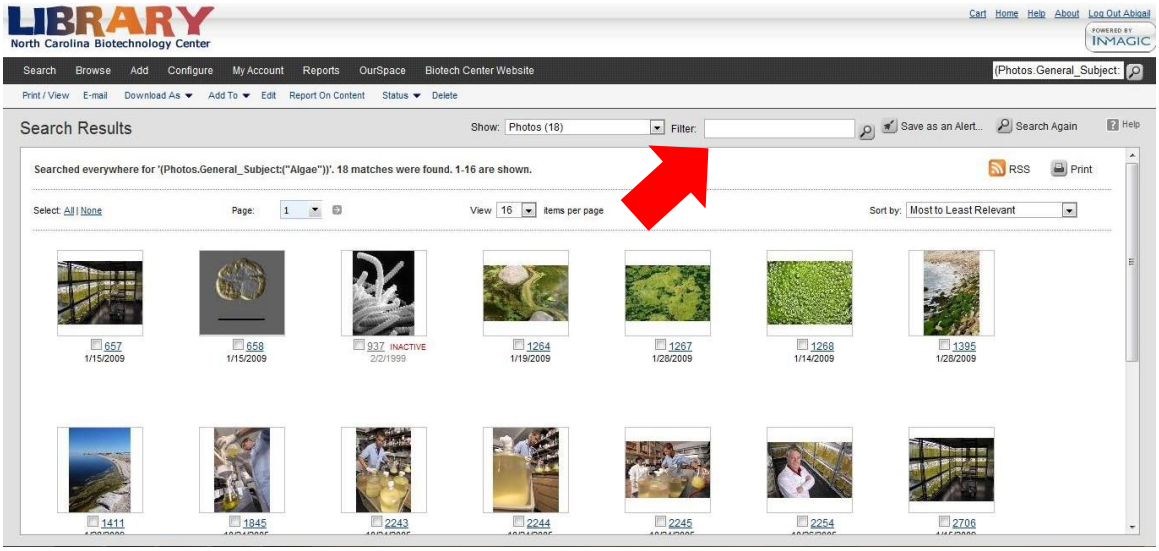

Figure 6: Search Results Page

While this feature does allow for some faceted searching, in that users can narrow down their results based on the keywords present in retrieved records, it still requires a lot of initiative on the part of the user to come up with terms to use for narrowing, and it does not allow for users to broaden their search results directly from the page. As Hearst says in a 2008 paper, “Faceted navigation is a proven technique for supporting exploration and discovery”, and the addition of a more robust faceted search capacity

would be a helpful feature and guide for searchers (Hearst, 2008, p. 1). Another issue that became apparent in the participants responses is the fact that there is no section on the Presto Database homepage that indicates where you go for image or photo searching:

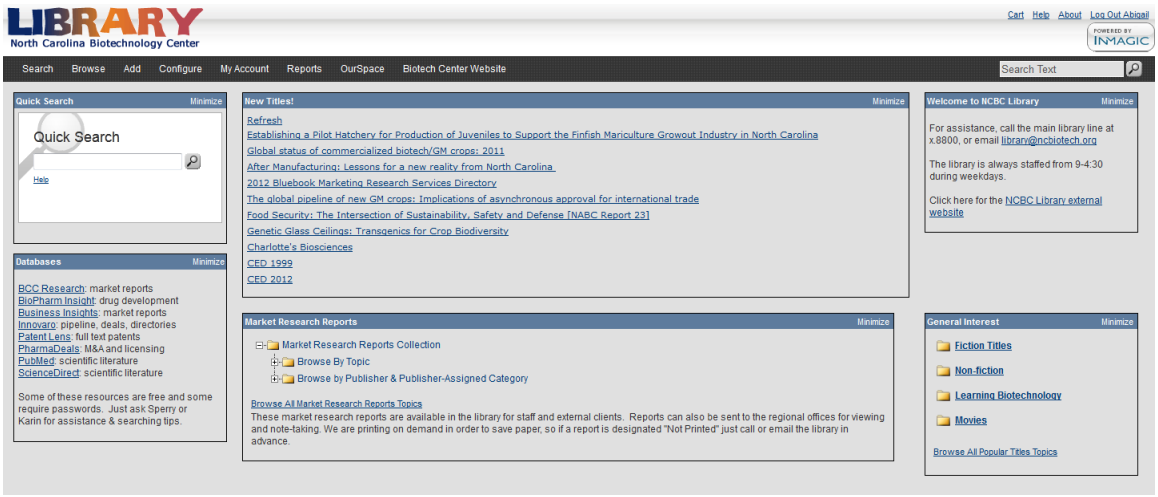

Figure 7: Presto Database Home Page

Users must know to click "Search" and navigate down to "Photos" to access only photos within a database that holds journals, metrics, and many other documents. This is not universal knowledge, as evidenced by responses to several questions:

Question: "What kinds of changes or improvements would make you more likely to use the Presto image database?"

> "...I would like for Presto to ask me what I am searching for before I input my search term so that I only see the results that are relevant to my search - i.e. I don't want to see articles when I am searching for images"

Since many users of Presto are using it solely for image searching, it would be optimal to have a tab for Images or Photos on the home page. If this is not a readily available update, a note by the search bar directing people to the Photos search function could also be helpful. As evidenced by several responses, the Quick Search Bar is how many users conducted their photo searches:

Question: "Please describe the steps you took when searching for images of _____ in the Presto Database":

"typed "trees" in quick search box and scrolled down to Photos"

"typed in 'trees' to the quick search box. looked for about 1 minute to see where i find the images section. chose drop down menu in Show box and selected 'photos'"

"typed "algae" in the Quick Search tool bar"

Figure 8: The Quick Search Bar is one of the most prominent features of the home page.

An additional issue with this method of photo searching is that photo results are displayed far below the fold on the Search Results page generated by the Quick Search, so users can easily become discouraged by the fact that the results they were looking for are not seen on screen. The presence of a faceted search tool anchored on the left hand side of the page would take advantage of the F-shaped reading pattern, ensure that photo results are not lost below the fold, and be familiar to users who are used to using popular, similarly set up browsing features like Google Images. By using the Quick Search bar, users do not have access to any controlled vocabulary term lists and cannot take advantage of their levels of specificity and potential for search efficiency.

4.2 – Potential for further research

In many ways this pilot usability study was limited by the confines of the image database capacity for examination. At the point which this research was conducted, the NCBiotech was waiting on a system upgrade for the Presto image database which would

have permitted viewing of logged user search queries. Regrettably, this upgrade did not come in time for the logged query function to play a part in this research study. When this upgrade is available, it is recommended that further research include careful examination of logged user queries. One way to analyze these queries is according to the "Panofsky-Shatford mode/facet matrix", which was used extensively in Armitage's 1997 analysis of user needs in image archives:

Table 5
Panofsky-Shatford mode/facet matrix

	Iconography (Specifics)	Pre-iconography (Generics)	Iconology (Abstracts)
Who?	individually named person, group, thing **(S1)**	kind of person or thing **(G1)**	mythical or fictitious being **(A1)**
What?	individually named event, action **(S2)**	kind of event, action, condition **(G2)**	emotion or abstraction **(A2)**
Where?	individually named geographical location **(S3)**	kind of place: geographical, architectural **(G3)**	place symbolised **(A3)**
When?	linear time: date or period **(S4)**	cyclical time: season, time of day **(G4)**	emotion, abstraction symbolised by time **(A4)**

Figure 9: Panofsky-Shatford mode/facet matrix (Armitage 1997, p. 290).

By coding user queries according to the terms delineated in the above table, a better understanding of the level of specificity required in description can be reached. Understanding the level of specificity within description and its effectiveness for searchers is cited as a key component to database functionality by Shatford Layne (1994). Pu's 2008 study analyzing failed queries for web-based image retrieval also points to the importance of understanding the level of specificity need by users; in this study, failed image queries had a much higher levels of specificity and conceptual description than successful queries. The ability to access user queries would provide a much keener

insight into how users actually search within the image database, compared to how users perceived the success and failure of search terms provided to them. The fact that searching tasks were provided to the users—instead of allowing users to come up with their own searching tasks—is one of the main limitations of this most recent pilot study.

Jörgensen's 1998 study on image attributes as noted by users employs what is called a “Descriptive Viewing Task” in which research participants were asked to describe what they noticed first, second, third, and so on, about images within a set (Jörgensen, 1998, p. 166). This user-generated description created a working list of terminology most likely to be used by users in accordance with the available images. Recreating this study with a group of representative images from the Presto image database would be beneficial, and a comparison could be made between the existing terminology and the user-generated terms. The order in which details are noticed could also be considered when determining the placement of description fields on searching pages.

A more elaborate modification with immeasurable value would be to increase the robustness of the semantic-space within images' description, a process detailed by Hare's 2006 study on semantic retrieval systems. The semantic-space describes the range of words that can be grouped together by association, such as singular and plural forms, and varying levels of specificity for a given concept. Hare provides the example of the relatedness between the words “horse” and “foal”, two different terms describing the same animal at different stages of life (Hare, 2006, p. 254). Presently, the Presto image database does not recognize any relatedness between words, so these distinctions must be included manually within the description field by the cataloger thinking of as many

synonyms as possible. Finding a way to automate this relatedness would save time for the cataloger, and it would also prevent frustration on behalf of the end-user conducting searches.

5.0 – CONCLUSION

There is a high level of reported user satisfaction in the initial research study of the Presto image database at NCBiotech, and there are numerous modifications that have the potential to make the database even more user-friendly. Although the benefits of the addition of the Abstract Subject field were difficult to determine, the fact that many participants used this field when it became available for the secondary searching task suggests that it does provide subject access that is helpful to users.

Along with the addition of abstract subject access, the research study generated information about users' habits when using the image database, namely that keyword search is prevalent and is usually the first step most users take. Only when a searching task becomes more complex are other options explored. With this information in mind, and with a general idea of which description fields are used the most when searching, several potential ways to modify the database's interface came to light. This includes the rearrangement of description fields so that highly used fields are placed prominently at the top of the page, and adding more information to the page about the description fields and their functions. Modifications regarding the design of the database pages, including the need for greater color contrast and relocation of the search and help functions were also noted as potential improvements.

There are many ways in which to further examine the database's usability. One of the main limitations of this study is that searching tasks were given to participants, so there is no way to tell how their experience might differ if they themselves were generating query terminology. The fact that queries were easily answered by simple text entry is another limitation. Further recommended research includes an examination of

user query logs—once this function is available—and conducting a descriptive viewing study to better understand how database users come up with terminology when searching. Creating more complicated searching tasks that require participants to take multiple steps to achieve results would also be a good way to gather more information about searching strategies and interaction with the database interface. In the meantime, this pilot study has provided a much better understanding of how employees at the North Carolina Biotechnology Center interact with the image collection and how this interaction may be improved.

BIBLIOGRAPHY

Armitage, Linda H. (1997). "Analysis of user need in image archives", *Journal of Information Science 4*(23), p. 287-299.

Besser, Howard (1990). "Visual access to visual images: The UC Berkley Image Database Project", *Library Trends 38*(4) p. 787-98.

Eakins, J. and Graham, M. (2000), "Content-based image retrieval" *JISC Technology Applications Program, Report 39.* p. 1-47.

Enser, Peter. (2000). "Visual image retrieval: seeking the alliance of concept-based and content-based paradigms", *Journal of Information Science 26*, p. 199-210.

Enser, Peter (July 2003). "Towards a comprehensive survey of the semantic gap in visual image retrieval", *Computer Science 2728* p. 291-299.

Elliott, Ame. (2001). "Flamenco image browser: Using metadata to improve image search during architectural design", in the *Proceedings of the ACM CHI 2001 Conference Companion*. Retrieved March 29, 2012 from http://flamenco.berkeley.edu/pubs.html.

Hare, Jonathon S., Lewis, Paul H., Enser, Peter G.B., and Sandom, Christine J. (2006). "Mind the gap: Another look at the problem of the semantic gap in image retrieval", *Proceedings of SPIE. Vol. SPIE-6073*, p. 75-86.

Hare, Jonathon S., Lewis, Paul H., Enser, Peter G.B., and Sandom, Christine (2007). "An in-depth analysis of a semantic image retrieval system" *CIVR* p. 250-257.

Hastings, Samantha (1999). "Evaluation of image retrieval systems: Role of user feedback", *Library Trends 48*(2), p. 438-452.

Hearst, Marti A. (2008). "UIs for faceted navigation: recent advances and remaining open problems", in the *Workshop on Computer Interaction and Information Retrieval, HCIR 2008*. Retrieved March 29, 2012 from http://flamenco.berkeley.edu/pubs.html.

Jaimes, Alejandro (2000). "A conceptual framework for indexing visual information at multiple levels", *IS&T/SPIE Internet Imaging 3964.*

Jörgensen, Corinne (1998). "Attributes of images in describing tasks", *Information Processing & Management 34* (2/3) p. 161-174.

Jörgensen, Corinne and Peter (2005). "Image querying by image professionals", *Journal of the American Society for Information and Science Technology 56*(12) p. 1346-1359.

Lange, Dorothea (1936). *Migrant Mother*. *Library of Congress Prints & Photographs Online Catalog*. Retrieved March 23, 2012 from http://www.loc.gov/pictures/item/fsa1998021539/PP/.

Nielsen, Jakob (2001). "Beyond ALT text: Making the web easy to use for users with disabilities". *Nielsen Norman Group.* Retrieved March 25, 2012 from http://www.nngroup.com/reports/accessibility/beyond_ALT_text.pdf.

Nielsen, Jakob (April 17, 2006). "F-shaped pattern for reading web content", *Jakob Nielsen's Alertbox*. Retrieved September 20, 2011 from http://www.useit.com/alertbox/reading_pattern.html.

Nielsen, Jakob (March 22, 2010)"Scrolling and attention", *Jakob Nielsen's Alertbox*. Retrieved September 20, 2011 from http://www.useit.com/alertbox/scrolling-attention.html.

North Carolina Biotechnology Center (2012). Mission & History. Retrieved March 18, 2012 from http://www.ncbiotech.org/about-us/mission-history.

Panofsky, Erwin.(1972). Chapter 1, "Introduction". In *Studies in Iconology: Humanistic Themes in the Art of the Renaissance.* (pages of chapter). New York: Harper & Row.

Pu, Hsiao-Tieh (2008). "An analysis of failed queries for web image retrieval", *Journal of Information Science, 34*(3) p. 275-289.

Rui, Yong (1999). "Image retrieval: current techniques, promising directions, and open issues", *Journal of Visual Communication and Image Representation 10*, p. 39-62.

Schaffner, Jennifer (2009). "The metadata is the interface: Better description for better discovery of archives and special collections", Synthesized from *OCLC User Studies Report.* Retrieved January 16, 2012 from http://www.oclc.org/research/publications/library/2009/2009-06.pdf

Shatford, Sara (1986) "Analyzing the subject of a picture: A theoretical approach", *Cataloging & Classification Quarterly, 6*(3), p. 39-62.

Shatford Layne, Sara (1994). "Some Issues in the Indexing of Images", *Journal Of The American Society For Information Science,45*(8), 583-588.

Shen, Xiangjun (2008). "Mining user hidden semantics from image content for image retrieval", *Journal of Visual Communication and Image Representation 19*, p. 145-164.

Stoica, Emilia and Hearst, Marti. (May 2004). "Nearly-Automated metadata hierarchy creation" from the *Companion Proceedings of HLT-NAACL'04*. Retrieved March 29, 2012 from http://flamenco.berkeley.edu/pubs.html.

Yang, M., Wildemuth, B., and Marchionini, G. (2004). "The relative effectiveness of concept-based versus content-based video retrieval" *Proc. ACM Multimedia ,* p. 368-371.

Yu, Ning (2012). "A multi-directional search technique for image annotation propagation" *Journal of Visual Communication and Image Representation 23* p. 237-244.

APPENDICES

Appendix 1 - Initial Searching Tasks Survey

1.) Please describe the steps you took when searching for images of trees in the Presto Database: (open-answer)

2.) How would you describe this searching experience? Select any that apply:

- Successful
- Unsuccessful
- Easy to figure out
- Confusing
- Too many results
- Too few results
- Easy to browse results
- Difficult to browse results

3.) What did you find useful when conducting this search? (open-answer)

4.) What did you find confusing when conducting this search? (open-answer)

5.) Please describe the steps you took when searching for images of a business partnership in the Presto Database: (open-answer)

6.) How would you describe this searching experience? Select any that apply:

- Successful
- Unsuccessful
- Easy to figure out
- Confusing
- Too many results
- Too few results
- Easy to browse results
- Difficult to browse results

7.) What did you find useful when conducting this search? (open-answer)

8.) What did you find confusing when conducting this search? (open-answer)

9.) How often do you use the Presto image database? Select the answer which best applies:

- This is my first time using it
- I've only used it a few times

- I use it at least once a month
- I use it at least once a week

10.) What kind of projects, if any, have you used the image database for? (open-answer)

11.) Have you received any kind of training or instruction for using the Presto image database? Select all that apply:

- Attended at least one GEEK session in person
- Attended at least one GEEK session remotely
- Viewed video of one or more GEEK sessions
- Received one-on-one tutorial in person
- Received one-on-one tutorial over the phone
- Read Presto Searching Guide
- Received answers to question(s) on an as needed basis

Appendix 2 - Secondary Searching Tasks Survey

1.) Please describe the steps you took when searching for images of trees in the Presto Database: (open-answer)

2.) How would you describe this searching experience? Select any that apply:

- Successful
- Unsuccessful
- Easy to figure out
- Confusing
- Too many results
- Too few results
- Easy to browse results
- Difficult to browse results

3.) What did you find useful when conducting this search? (open-answer)

4.) What did you find confusing when conducting this search? (open-answer)

5.) Please describe the steps you took when searching for images of a business partnership in the Presto Database: (open-answer)

6.) How would you describe this searching experience? Select any that apply:

- Successful
- Unsuccessful
- Easy to figure out
- Confusing
- Too many results
- Too few results
- Easy to browse results
- Difficult to browse results

7.) What did you find useful when conducting this search? (open-answer)

8.) What did you find confusing when conducting this search? (open-answer)

9.) If you noticed any changes in the Presto image searching screen, please describe: (open-answer)

10.) Please rate whether any perceived changes had an effect on your search. Select any statements that apply:

- I did not notice any changes
- I noticed changes but did not use the new fields
- Using the new fields made it easier to find useful results
- Using the new fields did not seem to have an effect on my search results
- Using the new fields was confusing
- Using the new fields made searching easier
- Using the new fields made searching more difficult
- The new fields will make me more likely to use Presto for image searching

11.) How often do you use the Presto image database? Select the answer which best applies:

- I've only used it for this study
- I've only used it a few times
- I use it at least once a month
- I use it at least once a week

12.) How often do you expect to use the Presto image database in the future? Select the answer which best applies:

- I do not expect my use to change.
- I will probably use it more often.
- I will probably use it less often.

13.) What kinds of changes or improvements would make you more likely to use the Presto image database? (open-answer)

14.) What department do you work for? (open-answer)