Visual Image Retrieval by Sample Selection

Nafiseh Bouhendi

Interaction Design Master Thesis, August 2012 @ K3 School of Arts and Communication, Malmö University
Supervisor: Bo Peterson

Examiner: Jonas Löwgren

Examination: 31 August 2012
Acknowledgement

This thesis would not have been possible without the support of many people:

I wish to express my gratitude to my supervisor, Bo Peterson, who was abundantly helpful and offered invaluable assistance, support and guidance.

Deepest gratitude are also due to the participants of my workshops, Anna Benckert, Ehsan Bouhendi, Maryam Bakhshandeh, Radmila Canic, Iman Bouhendi, Nuanphan Kaewpanukrangsi, Mojgan Safi and Behrooz Taleb, for their time, patience and very useful feedback.

I am particularly grateful for the great assistances given by my friends, Marcus Ghaly, Behrooz Taleb and Pouyan Tabiei.

Special thanks to all my friends and classmates for their feedbacks.

I would like to express my love and gratitude to my parents Masoumeh Parvari and Ebrahim Bouhendi, and also to my brothers Hosein, Ehsan and Iman for their supports, encouragements and endless love, through whole my life.
Abstract

The considerable growth of digital images online in recent years has shifted users' concern from whether or not an image is available to how to find a specific image in a sea of online imagery. Image Search Engines cannot satisfy every user, especially users that require specific images with more details. Furthermore, the variety and quantity of available images do not add value for users if they cannot find what they require in an appropriate timeframe. Therefore, an Image Retrieval is required that lets users define detailed search perimeters and find images that match their requirements.

This thesis focuses on providing better communication and interaction between users and Image Search Engines. The work presented here aims to let users describe their requirements visually and make approximations of the images that they require by setting perimeters like color, scale and position. This approximation can help in retrieving more appropriate images which more closely match users’ needs. This thesis also proposes to involve users first in improving the Image Search Engine database by uploading their photographs and images, and second in helping other users that are not satisfied with search results, by sending an image as response to their request.

To achieve this goal, the thesis applied two methodologies, Research through Design and User Centered Design. These methodologies allowed considering future possibilities and users’ requirements. The communication with users provided by low-fidelity and high-fidelity prototypes as sketches, that were used in workshops and helped in framing the concept and improving different aspects of it.
# Table of Contents

1. Introduction .......................................................................................................................... 1
   1.1. Motivation and Research Questions ............................................................................... 1

2. Image Retrievals and Terminology ....................................................................................... 3
   2.1. Data Domain ................................................................................................................... 3
   2.2. User Factors .................................................................................................................. 4
       2.2.1. User Knowledge .................................................................................................... 4
       2.2.2. User Purpose ....................................................................................................... 5
   2.3. Query Methods ............................................................................................................. 5
   2.4. Query Processing .......................................................................................................... 6
   2.5. Image Content .............................................................................................................. 6

3. Methodology and Process ...................................................................................................... 7

4. Current and Ongoing Image Retrievals ................................................................................ 9
   4.1. Examples of Metadata Image Retrievals ....................................................................... 9
       4.1.1. Search by Keyword .............................................................................................. 9
   4.2. Examples of Content-Based Image Retrievals .............................................................. 10
       4.2.1. Search by Image .................................................................................................. 10
       4.2.2. Search by Sketch ............................................................................................... 12
       4.2.3. Search by Color ................................................................................................. 13
   4.3. Examples of Composite Image Retrievals ..................................................................... 15
       4.3.1. Search by Sketch and Keyword ........................................................................... 15
       4.3.2. Search by Icon and Sketch ............................................................................... 16

5. Rethinking Our Interactions With Image Retrievals ............................................................ 18

6. What is an Icon? .................................................................................................................... 19

7. The Hypothesis of Iconic Search and its Assumed Features ............................................... 20
   7.1. Definition and Possibilities of Iconic Search ............................................................... 20
   7.2. Role of People in Iconic Search .................................................................................. 21
   7.3. Iconic Search’s Challenges ......................................................................................... 22
   7.4. Iconic Search Compared to Other Image Retrievals .................................................... 22
       7.4.1. Search by Keywords Compared to Iconic Search ............................................... 23
       7.4.2. Search by Image Compared to Iconic Search ....................................................... 23
       7.4.3. Search by Sketch Compared to Iconic Search ...................................................... 23
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>12.</td>
<td>Visual and Textual Features and Needs</td>
<td>52</td>
</tr>
<tr>
<td>13.</td>
<td>The Role of People in Iconic Search</td>
<td>56</td>
</tr>
<tr>
<td>13.1.</td>
<td>The Role of people in Improving Image Database</td>
<td>56</td>
</tr>
<tr>
<td>13.2.</td>
<td>Role of People in Sharing Images</td>
<td>57</td>
</tr>
<tr>
<td>14.</td>
<td>How to Get the Approximations That Are Requested From the Database</td>
<td>59</td>
</tr>
<tr>
<td>15.</td>
<td>Future of Iconic Search</td>
<td>63</td>
</tr>
<tr>
<td>15.1.</td>
<td>Iconic Search on Computers and Tablets</td>
<td>63</td>
</tr>
<tr>
<td>15.1.1.</td>
<td>Iconic Search in Simple and Advanced Modes</td>
<td>63</td>
</tr>
<tr>
<td>15.1.2.</td>
<td>Icon Color</td>
<td>65</td>
</tr>
<tr>
<td>15.1.3.</td>
<td>Categories and Sub Categories</td>
<td>67</td>
</tr>
<tr>
<td>15.1.4.</td>
<td>Editing the Steps</td>
<td>67</td>
</tr>
<tr>
<td>15.1.5.</td>
<td>Related Suggestions and Favorite Images</td>
<td>68</td>
</tr>
<tr>
<td>15.1.6.</td>
<td>User Groups and Related Categories</td>
<td>68</td>
</tr>
<tr>
<td>15.1.7.</td>
<td>Adding New Icons</td>
<td>69</td>
</tr>
<tr>
<td>15.1.8.</td>
<td>Overall Layout and Functionality</td>
<td>69</td>
</tr>
<tr>
<td>16.</td>
<td>Conclusion and Future Steps</td>
<td>74</td>
</tr>
<tr>
<td>17.</td>
<td>References</td>
<td>76</td>
</tr>
<tr>
<td>18.</td>
<td>Appendices</td>
<td>81</td>
</tr>
<tr>
<td>18.1.</td>
<td>Appendix A: Inspiration</td>
<td>81</td>
</tr>
<tr>
<td>18.2.</td>
<td>Appendix B: Other future possibilities of Iconic Search</td>
<td>83</td>
</tr>
<tr>
<td>18.2.1.</td>
<td>Iconic Search on Mobile Phones</td>
<td>83</td>
</tr>
<tr>
<td>18.2.2.</td>
<td>Iconic Search for Shopping Purposes</td>
<td>83</td>
</tr>
<tr>
<td>18.2.3.</td>
<td>Iconic Search for Personal Collections</td>
<td>83</td>
</tr>
<tr>
<td>18.3.</td>
<td>Appendix C: Indices and symbols</td>
<td>84</td>
</tr>
</tbody>
</table>
1. Introduction

Nowadays, with the considerable growth of the World Wide Web, it is easy to have access to different kinds of information, such as images, videos, maps, news, articles, etc. Users are no longer limited by time and location because the latest information is immediately available to them, anytime, anywhere. The role of Information Retrievals is to provide easy access to a user’s information interests. “Information Retrievals deal with the representation, storage, recognition of, and access to information items such as documents, web pages, online catalogs, structured and semi-structured records and multimedia objects” (Baeza-yates and Ribeiro-neto, 2011).

The quantity of information in different fields grows daily. The providers of this information are the near infinite number of sources and users from different parts of the world with different knowledge, aim and background. Therefore, there is no level of consistency in the information found online and the more information that is available, the more difficult it is to find specific pieces of information relevant to user needs. Therefore the user’s concern has shifted from a lack of availability of information towards finding relevant information, using a simple process in this search, and doing this within an appropriate timeframe (Kherfi, Ziou and Bernardi, 2004). The variety and quantity of available images do not add value for users if they cannot find what they require in an appropriate timeframe (Rui, Huang, and Chang, 1999).

The situation differs for different kinds of information. In contrast to the variety of text search engines that have successfully existed for many years, there are few image search engines that do not always satisfy a user’s requirements. One reason might be because it is hard to explain images and imagination through words and it is even harder to describe it to a machine (Datta, Li and Wang, 2005).

The surveys on Image search engines have grown considerably in recent years. An Image Retrieval (IR) or image search engine is a computer system that focuses on storing, organizing, browsing, searching and retrieving images from a large database of digital images (Baeza-yates and Ribeiro-neto, 2011)(Springmann, Al Kabary and Schuldt, 2010). Image search engines use different methods for search and address certain subjects and user groups, but the aim of all image search engines is to satisfy user’s requirements in an appropriate amount of time.

1.1. Motivation and Research Questions

Many of us might have been faced with a situation where we were looking for a specific image. We knew specifically what we wanted but could not find it exactly, so we had to make do with an image that was similar, and yet not exactly what we wanted. However, “similar” images are not always useful. Let us pretend a user is searching for a specific perfume bottle. The user may be able to remember exactly what the perfume bottle looks like, but did not know its name or brand. Using text-based search could require hours of mixing key words and reading through pages and pages of results. And yet the user may be able to easily draw or define the shape, color, and size of the specific perfume that is looking for.
These issues caused many questions regarding Image Retrievals, interaction between users and image search engines and why it is not possible to find certain types of images in an easier way. The main question here is:

- Which factors can improve the interaction between users and Image search Engines? This means, how users can specify their needs in more details or simpler process, and also how Image Search engines can retrieve images that are more relevant to users’ requirements?

The aim of this thesis is to find an answer for this question and provide a new option for users, in which they can define their detailed requirements through a simple process and satisfy with results. It is worth noting that while I consider different users, the main focus is on users who have specific and more detailed requirements in an image. It is also important to note that, while this work considers different aspects of image search, the main focus is not on search algorithms and technical issues, but instead the interaction between the user and the image search engine.
2. Image Retrievals and Terminology

It was not so long ago that people were limited to only take as many photographs as could be held on a single roll of film. Users had to be sparing about how to use this small number of photographs to have the best shots. The printed photos were also limited to certain physical locations; some even could not go further than personal collections. Later, scanners and digital cameras allowed people to go beyond these limitations. Nowadays, there are near endless amounts of images on almost every type of subject matter, allowing different users to seek their interested images. For example:

- A doctor might check the anatomy of human heart.
- A tourist might see some historical places in a city.
- A student might try to find some picture for his presentation as a starting point to explain his ideas.
- A photographer might look at different photograph archives.
- A police officer might check different fingerprints.
- And so on...

What is common among all these groups of people is that they want an accurate and relevant image, which suits their needs the best. That is when Image Retrievals come into play. There has been an ambitious attempt in recent years toward making better IR’s. Image search engines vary base on their users, use cases, features, and purpose.

To have a better look at the different aspects of IR’s, this section surveys different fundamental categories that affect image searches from either a user or system perspective. This information provides some basic knowledge and will be use later in other sections. IR’s can be classified base on data domain, user factors, query methods, query processing, Image content or a combination of these methods. It worth noting that the categories will be defined in this section might be more general compared to original definitions that are used as reference. The reason is to only consider categories that address the aim of this thesis.

2.1. Data Domain

Image search engines vary in term of the domain of images that they retrieve. They might support a small private scope of images, broad public scopes or other scopes located between. With respect to the data that Image search engines retrieve, image collections can be classified in four categories:

- **Personal Collection:** This collection includes images from a user. The user as the owner is the only one who has access to the images. Online photo albums are examples of personal collections.
- **Local Collection**: This collection contains images for a controlled group of users, who have specific objectives and are located near each other. Office workers or a medical centre staff, are examples of local collection users.

- **Wide Collection**: This collection, like a local collection, consists of images for a controlled group of users, but covers a broader range of topics. There are usually more users and they can be located in different parts of the world.

- **Global Collection**: This collection is available for any user anywhere in the world. Google, Yahoo and Bing are examples of global collections.

Different IR’s support these different types of collections. The main focus of this discussion is on global collections, which are public and accessible everywhere.

### 2.2. User Factors

Different users seek different kinds of information. What affects their search is not only their interests, but also their time, situation, knowledge, etc. These factors do not only classify different users, but also classify the same user from time to time. For example, the process of searching for a photo differs for a student when he is in class and his presentation will start in few minutes, compared to when he is at home and has a plenty of time. In the following section, two of the most important user factors will be discussed.

#### 2.2.1. User Knowledge

One important factor in seeking images is the user’s familiarity and knowledge about the requirements of the image they are looking for. Users do not always look for images which match their interests and knowledge base, and even when they do, users do not have same level of knowledge about the topic they are looking for. With respect to the knowledge users do have about elements of an image, searching for images can be classified in two categories (Springmann, Al Kabary and Schuldt, 2010):

- **Search for known items**: The user is familiar with the items and perhaps knows how to find them.

- **Search for (potentially) novel items**: The user is not familiar with the items, perhaps does not know exactly how to find them, but still needs the items that satisfy his requirements.

The second situation is more time consuming and it is likely that the user will not find an image that matches his requirements if his first efforts do not lead to appropriate information.
2.2.2. User Purpose

Another important feature that affects the expectations for a search engine and the interactions with it is the user’s intent or degree of specificity about what they desire (Datta, Joshi, Li and Wang, 2008). This factor classifies the users into three categories:

- **Browser**: This is a user who does not look for specific pictures. This may be either because he does not have a clear idea about what he desires or because he just wants something as a result and it does not much matter. A browser usually spends more time looking at a variety of different images. A browser might use diverse queries for search. An example of a browser is a user who is interested in animals and looks for cute cat images.

- **Surfer**: This is a user who has a moderate clarity about what he is looking for. A surfer user is more specific with his queries. He might start with some broad topics, but they will lead him to his final goal. An instance of a surfer is the person who looks for must-see places in Paris.

- **Searcher**: A searcher is a user who has specific requirements in the image that he is looking for. The search process will continue until he meets his requirements. An example of a searcher is a user who looks for an image of the Eiffel Tower from a specific angle.

2.3. Query Methods

The interaction between the user and image search engine starts with the user’s requirements definition through queries. The current query models for IR’s can be mainly divided in four groups (Datta, Joshi, Li and Wang, 2008):

- **Keywords**: In this model the user enters one or a combination of words which describe his requirements. For example, the user types the word “bicycle” to find images of bicycles.

- **Images**: In this model the user utilizes an image to start a search. The image can be uploaded from the user’s computer or be a link to an online image. In other words, the user defines an example of his requirements. For instance, he uses an image of bicycle to find similar images of bicycle.

- **Graphics**: This method utilizes user pictures, such as sketches, illustrations, symbols, etc. For example, the user might draw a bicycle to start the search.

- **Composite**: This method includes two or all three query models mentioned above. For instance, a user might use both keywords and sketches to define his requirements.

The examples of IR’s that use each method will be described later in section 4.
2.4. Query Processing

After users define their requirements through queries, the system should understand and analyze their inputs to retrieve appropriate images. The image search engine can analyze the queries in mainly three different ways (Datta, Joshi, Li and Wang, 2008):

- Metadata: In this model the search engine utilizes additional information that describes an image to retrieve multiple image results. The information can be keywords, tags, texts, etc, which describe the content, size, color, resolution, creator, etc of an image. For example, when a user types “bicycle” the IR searches the database for the images that contain “bicycle” in their metadata and then presents them as the result.

- Content-Based: A content based search engine analyzes the queries based on their actual content such as color, texture, shape or other information that can be obtained from the image itself. The search engine uses the content of images for its sampling data to retrieve the result. For example in the model that detects color, when a user combines red, yellow and orange with a drawing tool in paintable region of the search engine, the search engine retrieves images of sunsets or other items that contain those combinations of colors. (Zheng and Gao, 2008)

- Composite: This model uses both models mentioned above to analyze the queries. For example, when the user types “bicycle” and adds red, yellow and orange colors in paintable area, the system retrieves images of bicycles at sunset or it returns bikes that are painted red, yellow and orange.

The examples of IR’s that use each method will be described later in section 4.

2.5. Image Content

The contents of images vary in their degree and level of complexity. They can represent simplistic visual elements such as edges, textures and colors, or they can represent complex elements such as geometrical shapes or three dimensional structures (Eakins, Briggs and Burford, 2004). Burford et al (Eakins, Briggs and Burford, 2004) categorizes image contents into ten groups, but for the purpose of this thesis the focus will be only on two fundamental categories:

- Semantic units: This term refers to the name of one or more groups of substances that may represent general entities such as different kinds of flowers like “lilium” or parts of nature like “sea”. It may also represent individual or unique entities such as the names of authors, celebrities, landmarks, etc like “Issac Newton” or “the Statue of liberty”.

- Abstractions: This term refers to contents that are not directly visible in an image, but derive from a sense, mood, or tone present in an image. These images can represent emotions, cultures, problems, diseases, techniques, etc. “Sadness”, “sustainability” and “addiction” are examples of abstraction.
3. Methodology and Process

“Interaction Design refers to the shaping of digital materials – software, electronics, telecommunication, etc – with a particular focus on the use of the resulting digital artifacts” (Löwgren, 2007). It is “heavily focused on satisfying the needs and desires of the people who will use the product” (Cooper, Reimann and Cronin, 2007). In other words, Interaction Design “Focuses on how to identify users’ needs, and from this understanding, move to designing useable, useful, and enjoyable systems” (Preece, Rogers and Sharp, 2002).

Interaction Design is not only about having smarter, more efficient and faster systems, which might be the main focus in software engineering or Human Computer Interaction (Löwgren, 1995). It is also about having better communication and interactions between people and systems, which provides an intuitive, seductive, pleasant and satisfactory experience for users (Löwgren, 2007). To achieve this goal, the process for the work presented here was shaped by both Research through Design and User Centered Design.

Research through Design, focuses on “making the right thing; artifacts intended to transform the world from the current state to a preferred state” (Zimmerman, Forlizzi, and Evenson, 2007). This preferred state fills the gaps of current state.

“The philosophy behind user-centered design is simply this: users know best. The people who will be using a product or service know what their needs, goals, and preferences are, and it is up to the designer to find out those things and design for them.” (Saffer, 2007). “Designers should try to fit products to people instead of the other way around.” (Saffer, 2007)

Research through Design and User Centered design complemented each other, because Research through Design let me think broadly and consider different possibilities while User Centered Design let me involve users as co-designers and allowed me to be a co-learner and know more about users’ requirements.

My thesis work started with finding a gap in IR’s; how they do not let users define their requirements and how they cannot satisfy all users, especially the ones who need specific images which need more details. I started with a literature review to know the area better (Kumar, 2011) and explored the implications and requirements of searching for images. Section 2 described the important terms that are required.

I continued with verifying and testing current and ongoing IR’s to understand their advantages and disadvantages. In this part of process I had a qualitative research (Kumar, 2011). This means that I did not focus on statistics or technical issues, but instead on more broad questions such as how much are they useful or which elements should they contain? Section 4 will describe the information that gathered in this step.
Analyzing the gathered information led to a hypothesis which could be a possible future-tool and solution to fill the discovered gap in IR’s. Sections 5, 6 and 7 will explain the objectives and assumed features.

While designing a possible future-tool, it is important that people that are affected by this design and participate in the design process as co-designers (Ehn, 2008). Communication with users provided through two sets of workshops with different users. The workshops let us research, communicate, critique, change and improve the main idea. These workshops facilitated reflection in action (Schön, 1987) (Löwgren, 1995). The workshops and communications were not possible without using low-fidelity and high-fidelity prototypes as sketches, which let users understand the main concept, experience and assume some of its features roughly. (Löwgren, 2008) (Löwgren, 2012). Sections 8 - 11 will describe the prototypes, workshops and the information they provided.

The information and interpretations from each workshop provided base for next steps. The analyzed data from literature review, verifying and testing other examples, first and second workshop let to the final decision about possible future of the image search engine. (Figure 1)
4. Current and Ongoing Image Retrievals

With the definitions of different categories related to image search engines mentioned in the previous chapter, this section explains some examples of IR’s and surveys their advantages and disadvantages. Since there is a large variety of IR’s and it is not possible to cover all of them, the focus here is on IR’s that are more relevant to the aim of this thesis. Specifically, I have focused on the ones that are publicly accessible online and available to the reader to experience first-hand. We will look at these examples base on the query models they use.

4.1. Examples of Metadata Image Retrievals

4.1.1. Search by Keyword

These days the most common way to search for images is searching through keywords. This type of search has existed for a long time. Google, Yahoo and Bing are the most famous search engines that support search by keywords. In this model, users type the keywords of what they are looking for. For example, the user types “cat” to find different pictures of cats. The system then shows different thumbnails of cats which have the metadata or index of “cat” in the database. These search engines are broad and contain both “image content” categories mentioned previously, semantic units and abstractions.

However, these IR’s have some problems. Today, if a user searches Google Images (2012) for the word “cat”, the result is about 58,600,000 images. To limit the search, the user can add more information, like “black cat”. The result changes to about 20,400,000 images. These two examples and their results might be useful when the user is just looking for a (black) cat and does not have any other requirements, but sometimes the user requires more detail and is looking for a specific type of picture. For instance, the user might try to find a “black cat near bench and tree”. This search in Google returns about 3,280,000 results. Although the user might find what he is looking for, the result also includes many images that are irrelevant. The user has to spend an unrealistic amount of time and look at countless irrelevant pictures such as a girl on a bench, a tree trunk bench, black cats, trees, etc, to finally find an acceptable image (Figure 2).
In addition, search by keywords also depends on the words that are used as search terms; Synonym can sometimes drastically change the result. Different people use their own vocabularies, which makes it hard both for indexing and finding images.

Another factor that makes search by keywords insufficient is the inability for users to select the position of items in the picture, especially when the user is trying to find a picture with a specific appearance. In the previous example, the user cannot describe where the cat, bench and tree are located in the image. Is the cat on the right, the bench in the middle, and the tree on the left? Or are there lots of trees in the background and the cat and bench are in the middle?

Considering all these features, while search by keyword might be appropriate for a Browser or a Surfer, it might not satisfy a Searcher’s requirements, especially if he does not have sufficient time to look through full list of results. Keyword search is also not very useful for items that are known to the user by sight not by name, because the user does not know the correct words to begin his search. Guessing with random keywords is not only insufficient in returning valuable results, but also takes more time and energy on the part of the users to find what they are looking for.

4.2. Examples of Content-Based Image Retrievals

4.2.1. Search by Image

In search by image (2012), instead of using text or keywords, users utilize an image to begin a search. The result might be the same image, similar images or other types of information that is related to the
original search image. Users can add an image URL for images that exist online or upload a photo from their own computer. “Google Images” (2012) is one example of a search engine that finds content based on a search picture.

While this service might be very useful in some searches, it has its own disadvantages and limitations. Consider a user that has an image of white flowers and wants to find similar images (Figure 3). Based on the white flowers in the figure, the user retrieves about 496,000 results. This result contains a few white flowers at the beginning while the rest of images are irrelevant, such as flash memory sticks, a planet, snakes, a football icon, etc. In this example, the search returns images that contain mostly the same colors rather than same item. Image search also does not let users use one type of content to search for another type of content. For instance, it is not possible for the user to upload a sketch of a cat and see photographs of cats in the search results. Instead, what the user gets is mostly sketches (Figure 4).

In addition, users cannot define potential changes that they might want in similar images. Are they looking for exactly the same appearance, the same image in different seasons or the same image in different alignments? Furthermore, Users must start with an initial reference image in order to actually search for similar images, but an initial image is not always available. In general, users usually do not have a sample of the image that they are looking for. This type of search might be more useful in some fields like biology where the user already has images of a cell and is looking for similar images of the same/similar cell. It might also be useful for photographers who are looking for images that are similar to photographs they have already taken.

![Figure 3. Search results for white flowers showed at the top right of image.](image-url)
Last but not least, search by similar images can support Semantic Units if users have a collection of existing images, but is probably not sufficient for Abstractions. Search by image works based on the similarity of the images, but Abstractions are not visible in the image itself.

TinEye (2012) and Google Goggles (Google Mobile, 2011) are other examples of using an image to search for information. TinEye is a reverse search engine which lets owners of copyrighted images see if their imagery is being used online without authorization. Google Goggles is an application that allows Android users to capture a photo with their phone and use it to search the web. In this case the users do not have difficulties finding initial reference because they can take a photo with their phone, However they still cannot define any changes that they might require. Because these search engines are for specific purposes or specific devices, they are out of scope for this thesis and will not be discussed more.

4.2.2. Search by Sketch

The search by sketching (drawing) method utilizes user generated sketches as search queries. The “unofficial Google search by drawing” (2011) is one of the prototypes that uses this method (Figure 5). This method lets users specify their requirements directly, such as the size and position of items in the image. Search by drawing can almost be useful for all types of users; for a Browser, a Surfer and especially a Searcher. This can be helpful for both known and novel items if the user knows the appearance of the image he is looking for.

However, search by drawing has a number of problems. First, it cannot contain all the elements of an image. It is not always possible to draw abstractions such as addiction, sadness or sustainability. Second,
drawing with a mouse might be hard for users. It is easier for users who have a tablet or special pens for this purpose. Third, people have different skill levels for drawing. It is not realistic to assume that everyone can draw an image, and this task becomes harder when users need to draw from imagination. User’s ability to draw also affects their search time; the slower a user is at drawing the more time he has to spend making an image. If the requirements to use the system are too high, then users might switch to other forms of search.

In addition, search by sketching depends on scale, spatial arrangement, and so on. Can users draw at the correct scale? What about 2D and 3D objects? In addition, users usually draw what is important and interesting for them, but that might not be the exact details that are important and required by the search engine being used (Springmann, Al Kabary and Schuldt, 2010). As this model is not completely implemented yet, the artistic requirements and the quality of search results still remain unclear.

4.2.3. Search by Color

In search by color, users can define the colors of elements that they require. The results are images that contain the same or similar colors. “QBIC color search” (2003) and “QBIC Layout search” (2003) are two IR’s that follow this method. They both contain paintings and use color as the materials that an artist uses to form a search query. Figure6 illustrates that users can specify the colors they require from a spectrum and set the proportion of each color. This method returns all the images that contain these colors, regardless of image composition. Figure7 shows that users can also define the layout of colors by using round or square shapes to define the composition of the image.
Figure 6. Left: Search by QBIC Color. Red, light blue, dark blue, yellow and green are selected. Right: Result of the search.

Figure 7. Left: Search by QBIC Layout. Blue, green, brown, yellow and orange are defined in square or rounded shapes. Right: Result of the search.
Another IR that uses this model is “idée multicolor (Multicolor Search)” (2012), which contains about ten million Flickr (2012) images. It lets users specify up to five colors and set the percentage of each color (Figure 8). It is similar to “QBIC Color search”, but it is not limited to a specific domain like paintings.

Figure 8. Result of search by color in Multicolr. The selected colors have been shown at the bottom right side.

Search by color can be useful for some types of searches, especially in the previous two examples when users were searching for paintings. It can also be helpful for commonplace objects such as the sky, sea, mountains and plants, but it does not allow users to describe additional details or specific items they are looking for. For example, it is not possible to define a vase in any of the search by color methods mentioned above. In addition, as the query is based on color, it is necessary to use the correct color. Here the user might not know exactly which specific shades of yellow, orange and red might lead to the sunset he is looking for. This might be even worse when the items a user is searching for are novel or when the user cannot recall an item and its colors clearly.

In light of these arguments, search by color can be useful, but only in specific and limited areas. In addition, while it might be useful for Browsers, it does not always allow Surfers and Searchers to describe their needs specially enough.

4.3. Examples of Composite Image Retrievals

4.3.1. Search by Sketch and Keyword

Some IR’s let users describe their needs both by sketching them and adding additional keywords. “Search by sketch” is one example of this type (Springmann, Al Kabary and Schuldt, 2010). In this model
as users start drawing, the IR returns images that are similar to their sketch. However, what users draw might not always look like the object they had in mind, and so users can specify additional keywords to improve search results. For example, an airplane drawn by a user might resemble another object, such as a plant, so the user can add a keywords like “flying” to clarify and limit the search results (Springmann, Al Kabary and Schuldt, 2010) (Figure 9). The users can also clarify their search by adding more details, such as airplane windows, clouds and birds to their drawing.

![Image](image_url)

Figure 9. Result of searching airplane by sketch and keyword. The user adds “Flying” to clarify and limit the search.

While combining both text and illustration eliminates some limitations present in other IR’s and may allow users to additionally search for abstractions, the problems previously mentioned for search by sketch are still present here.

4.3.2. Search by Icon and Sketch

“ImageScape” is an image search engine that lets users utilize sketching and a few semantic icons to visually describe their requirements (Lew, 2000). To search for an image, users can add icons in the locations where they want specific items be in the resulting pictures. For example, users can add a “sand and stone” icon beneath a “sky” icon and above “trees and grass” icon (Figure 10). They can also add a rough sketch to further clarify their search. As this model of search is not completely implemented yet, many aspects of it remain unclear. In general it seems that while this model addresses some of the problems of search by keyword previously mentioned, such as the position of items, the problems raised for search by sketching may in fact be very similar.
Figure 10. Two examples of query by icons. (a) query for a person with trees and grass above and below him; (b) Result for “a” query. (c) query for sand and stone beneath sky and above trees and grass; (d) Results of “c” query.

There are additional image search engines for specific purposes such as search with screenshot for graphical user interfaces (Yeh, Chang and Miller, 2009), search historical ottomans (Ataer and Duygulu), search by airlines (Airliners.net, 2012) and different image searches for law enforcement purposes, which are out of scope of this discussion.
5. Rethinking Our Interactions With Image Retrievals

In the previous section we surveyed examples of different IR’s. While there is a variety of available IR’s, their ability to fully satisfy user needs is still lacking, especially for Searchers. On one hand we have metadata search engines which are simple to use, but it is not possible to define detailed requirements. On the other hand we have content-based and composite search engines, where some IR’s might let users describe more requirements, but they are not as simple to use as metadata search engines and they require some degree of illustration skills or initial reference images.

Most of the efforts in recent years have focused mainly on improving content-based and composite IR’s. While this is very useful from systems perspective and eliminates the need for indexing, it might not be as useful from the user perspective, especially for Searchers who need to be able to easily define their requirements and quickly look through the search results (Bhattacharya and Rahman). What is important is that search methods not only have smart systems, but also have systems that provide better interactions and greater functionality for users. It would appear that the interaction and user-facing aspects of IR’s have received less attention than engineering related issues (Eakins, Briggs and Burford, 2004). In addition, the role of the users and how they not only interact with the system, but also affect and improve it, has been ignored in many of the current IR’s.

However, content-based and composite IR’s have something which can be very helpful for some users, namely the use of an image’s visual components to help with search. In contrast to commonly used search engines that mainly use keywords, where users must convert what is visual in their mind into text in order to receive search result, Content-Based IR’s allow users to leverage visual elements in their searches. But what if it was possible to keep this important feature, but house it in an IR that was designed to be much simpler to use? In other words, what if it was possible to have the simplicity of metadata search engines, such as search by keywords, but still use the visual qualities of content-based and composite IR’s? In a system like this, users could define their search criteria more quickly and easily than with current IR’s, and without the need for drawing skills or reference images.

While there might be many different ways to do this, one of the ways, which is the goal of this thesis, is to use pre-existing “icons” and combine them with keywords (if required). This method, “Iconic Search”, lets users utilize both visual and textual information to define detailed search criteria in a quick and easy process, without needing prerequisites images, skills, and so on. This idea also tries to engage users in providing images and helping other users.

It should be noted that the focus of this thesis is not on search algorithms but rather on the interaction of users with IR’s. The details of the initial idea, which led to further steps in the design process, will be discussed in section 7, but before this it is necessary to describe a number of terms and concepts. To begin with, what do we mean by the term “icon” in this context.
6. What is an Icon?

In the context of Iconic Search we use the word “icon”, which to be defined correctly for the purposes here we must look to semiotics and “Signs”. Simply put, semiotics is the study of “signs”, their structure and the meaning behind them (O’Neill, 2008). Signs can be combine words, sounds, body language, context, etc in a way that creates a visual language and lets people understand things, like a feeling, a concept or a path (O’Neill, 2008).

We can refer to linguist Saussure and the professor Peirce as the founders of the semiotic. According to Saussure a sign consist of two parts, a signifier and a signified.

- Signifier: Is the representation of the concept or the form that it takes.
- Signified: Is the concept that is behind the sign and the meaning that it brings to mind. (O’Neill, 2008) (Chandler, 2009)

For example, when there is a scissor sign on the carton of fruit juice, the signifier is the scissor and the signified is the meaning “open from here”. The signified and signifier together make a meaning, and as a result a sign. This means the same signifier combined with another signified creates another meaning, and the other way around (O’Neill, 2008) (Chandler, 2009). For example, a scissor on a door might represent a hair salon.

Peirce however defined signs differently. He categorizes the signs into three fundamental groups, icons, indices and symbols: (O’Neill 2008) (Chandler, 2009)

- Icon: This is a sign that stands for an object by resembling it. “Icons are signs that represent their objects via a direct likeness or similarity”. In other words, an icon is a signifier that resembles the signified. Photographs, images, paintings, illustrations, diagrams, maps, etc that have a similarity to the other object(s) they represent are examples of icons. (See Appendix C : Indices and symbols)

In the context of Iconic Search, The word “icon” refers to the definition provide by Peirce; a sign that represents its subject via a direct likeness or similarity.
7. The Hypothesis of Iconic Search and its Assumed Features

7.1. Definition and Possibilities of Iconic Search

Before the idea of Iconic Search can be fully explained, let us first refer to the function analysis method, which aims to “express what the future product should do” (Löwgren and Stolterman, 1999). According to this method, there are four types of functions (Löwgren and Stolterman, 1999):

- Main Function: This is the primary and essential idea and goal of the product.
- Necessary Functions: These are other functions that are required for supporting and completing the main goal.
- Desirable Functions: These are functions that are not necessary but are nice to have all the same.
- Unnecessary Functions: These are functions that were initially proposed but later abandoned.

In this section I will describe the Main Function of Iconic Search. Section 7.2 will describe both the Necessary and Desirable functions of Iconic Search. This is notable that these functions in this level were determined by me, but they will be discussed and tested by users in future steps.

The hypothesis of Iconic Search, a completely new type of IR, aims to provide better communication and interaction between the user and IR. When searching for images, where users define their request and get a result, better interaction means a way for users to describe their requirements in a simple and quick process and get an appropriate result that matches their requirements. (See Appendix A: Inspiration)

To achieve this goal the hypothesis of Iconic Search, which uses metadata, has two main features:

- First, let users define their requirements visually, by using an available set of icons. Therefore, to start a search the user adds an available icon to the screen. The icons represent different objects such as landmarks, animals, flowers, etc, which are separated in different categories. Consider a user that is looking for cat images. In this example, the user adds a “Cat” icon from the animal category of available icons (Figure11). By adding the icon, the user can see different images that contain a cat. To limit the search results, the user can add more icons to the screen.

- Second, let users describe the images they are looking for by approximating visual details. This means users can select the color, scale, position, and rotation of icons to better specify their search criteria. Thus, returning to the example of searching for “a cat near bench and tree” the user can define a cat in the middle of a chair and tree, or a cat on top of a chair near the tree, and so on.
Defining the requirements of an image visually, could help in retrieving an appropriate image that more closely matches a user’s requirements. In general it seems that Iconic Search could potentially allow different groups of people with different knowledge, age, language, ability, and background to define their requirements by adding icons to their search.

7.2. Role of People in Iconic Search

A Necessary Function (Löwgren and Stolterman, 1999) of Iconic Search, which is a major difference of this model with other image search engines, is the role of people and the way they can interact with the system. In this model people are not just users of images, but also providers of images. This means that not only can a person find the pictures he wants, but he can also upload an image, tag the icons and words that an image contains and add an image to a database. In this way the user improves the database and allows other users to utilize his pictures. More details about role of people in improving the database will be described later in section 13.
A Desirable Function (Löwgren and Stolterman, 1999) of Iconic Search is to let people help one another. There may be times when the specific type of image a user is looking for might not exist or the search results might not be satisfactory, while another user might possess a satisfactory image on their local hard-drive. This system aims to allow people to make search request directed at a community of users, as well as an image database. Other users then can verify these requests and if they have an image that matches, they can add it to the database. More details about this feature will be discussed later in section 13.

7.3. Iconic Search’s Challenges

While the hypothesis of Iconic Search could provide some useful options for users, but from a technical perspective it has a number of downsides:

First, it cannot be as broad as search by keywords, where users can search different topics and even use a search to check the meaning of a word by looking at the image based search results. Iconic Search is limited to certain categories and it is not a good general purpose search tool for finding things like celebrities, maps, etc.

Second, Iconic Search is limited to a certain number of icons. While it attempts to cover many possible requirements, there might still be icons that users need in addition to what is provided. However, it might also be possible for users to define and add icons or request an icon be added to the search tool (See section 13).

Third, in some instances Iconic Search could potentially be more time consuming as compared to the other methods mentioned previously, because users must first find an icon before they can start querying an image database. However, if the icons of each category can be ordered base on their name or their rank of usage, it might become much easier to find them. A description for each icon can also help in finding them, especially if the user is not familiar with the appearance of the item that is being looked for.

In this early stage many details and questions needed to be addressed, such as should it contain a text as a description of the icons? Should it contain image rotation? Is it possible to find more details such as where the cat is looking at? Is it possible to include different actions or emotions as well? Should it be for a specific group of people with specific purposes? How many icons should it include? More research and Several workshops and prototypes were used in an attempt to answer these questions.

7.4. Iconic Search Compared to Other Image Retrievals

The first question that we must ask after the hypothesis of Iconic Search is if it can really add value for users or not? To answer this question and also clarify the benefits of Iconic Search, this section compares Iconic Search with the different IR’s mentioned in section 4. It is worth noting that Iconic
Search does not aim to be used instead of these models, but instead tries to provide another option for users.

### 7.4.1. Search by Keywords Compared to Iconic Search

Both of these models use metadata for search queries. Although search by keywords is much broader than icons, it is less effective when the number of required items increase. It is also not possible with keywords to define the position and size of items in an image. Iconic Search is more limited in its scope and takes more time from the user, but it lets users describe their requirements in detail.

The whole process of searching for photos by keyword converts what is visual in the mind to words and then words back into visual. In Iconic Search, the user can use the icons which are visual to find photos which are visual as well.

In Iconic Search, if the icons have text descriptions, this text can help users find icons when the user does not know what a particular icon looks like. For example, a user might not know what a lilium flower looks like in the flowers category of icons. Here, the user has both the visual icon and text description to help them select the correct icon.

In addition users can use Iconic Search regardless of their language. The shape of an apple is same all over the world, while the word for apple differs in different languages.

### 7.4.2. Search by Image Compared to Iconic Search

While search by image is easier for finding similar images, it is not possible for the user to define changes in the original image that might be required. The user also needs an initial reference image, which is not always available. In Iconic Search the user is the one who defines the items and their position in the required image. The icons are always available and the user just needs to select and place them.

In addition, in search by image the user gets the same type of image in their search results as what they used to query the database. This means the user cannot use a sketch of a cat to find a photograph of real cat. If the user starts with a sketch they will only gets different sketches as search results. Iconic Search lets the user find different types of images like photos, sketches, icons, etc.

### 7.4.3. Search by Sketch Compared to Iconic Search

Although both these models let users define their requirements through imagery, searching by icons lets the user select the items and locate them in an easier and faster way. In search by sketching users must draw their requirements by hand. It might be a hard and time consuming task for users to draw their needs, and they might not remember what certain objects look like. But it might be easier for users to find objects in a list of readily available icons, and then place these icons to search for images.
In addition, in Iconic Search, it is easier for users to add, remove, or replace certain elements within an image. For example, the user can change the position of the cat icon or even replace it with a dog icon easily, while it is much harder to manipulate a sketch like this and may require users to start a new sketch all together.

7.4.4. Search by Color Compared to Iconic Search

Search by color does not let users explain the visual details of their search requirements. It also does not let them describe the items they want an image to contain. It only allows users to define several colors that should be included in the resulting image and in the best case, the location and layout of those colors as well. Iconic Search allows users to define visual elements and their details.

While Iconic Search could include colors, it might not support a full spectrum of colors but instead have a limited set. This limitation in colors could make it easier to set the color of an icon, but also might lack enough detail to search for specialty items like pieces of art.

7.4.5. Search via ImageScape Compared to Iconic Search

Both these models use icons and allow users to describe their required approximation, but ImageScape relies mainly on a few generic icons and the rest is dependent on the user drawing images. Iconic Search contains a significant number of icons for different object types and categories which let users utilize icons for visual details, not only for general subjects.

Both of these search engines try to go beyond the limitations of using icons alone by using an additional feature. Iconic Search lets users utilize keyword, which are easy and fast to define while ImageScape let users draw their requirements, which is harder and more time consuming. In addition, the problems related to drawing that were mentioned for search by sketching are the same for ImageScape.

7.4.6. Conclusion and Moving Forward

In light of the advantages and disadvantages mentioned in this section, Iconic Search has several strong points when compared to other IR’s. This suggests it could be used as an alternative search option which provides useful features for users. Figure 12 compares the positive and negative features of Iconic Search and the previously mentioned IR’s. The next step was to investigate Iconic Search and see how users felt about it.
Figure 12. Features of different IR’s. Green: represents positive features. Red represents negative features.
8. Investigation of Iconic Search

The hypothesis of Iconic Search and research around that left lots of unanswered questions:

- Usability: Is Iconic Search actually usable? Would it really help users to define images digitally they can see in their minds? Can it satisfy the users’ search requirements?

- User Group: Can it be useful for any user or will it only be able to address a specific user group.

- Use cases: What kind of images can it support? Is it useful for any type of content? Or should it only be considered for specific subject matter, topics, or purposes?

- Requirements: What do people actually need to visually define their search requirements? What kinds of icons are useful? Do users need text to describe and complement the icons? Do they want to use colors?

- Technical Requirements: What type of database would need to be constructed so that a user could perform an Iconic Search, and how would its features tie into a server?

Because the main users of “Iconic Search” are people, I decided to have a number of workshops with different users to try and find answers to these questions.

8.1. The Low-Fidelity Prototype of Iconic Search

To define Iconic Search for users and help them understand and test its performance and functionality, it was necessary to simulate the search engine’s assumed abilities, such as being able to easily define icon size, color and position. But because illustrations and wireframes could not let users test functionality and features, I decided to use the photo editing program Photoshop, which lets users adjust things like size, position and color. The icons where located in folders next to the Photoshop canvas. The folders represented different categories of icons. The icons were black and white illustrations in transparent (.png) format which let users combine and color them easily (Figure 13).
Figure 13. Low-fidelity prototype of Iconic Search. The left side shows available categories and icons for the flower category. Users can add icons to the Photoshop canvas on the right.

To build a searchable image, users could add icons from the available categories to Photoshop and resize and relocate the icons to define their requirements and make an approximation of the image that they were looking for. The prototype was intended to be like a sketch, and quickly explain the concept, test ideas, and communicate with users (Löwgren 2008) (Löwgren 2012). The purpose of prototype was not to check the results of Iconic Search, but the way it let users define their requirements. The role of people in improving an image database and helping other users was outside the domain of this prototype and will be discussed later in section 13.

8.2. The First Workshop

The workshop(s) was with four people on different days. The participants were from different backgrounds: a graphic designer, an architect, a software engineer and a telecommunication engineer, who were between 25 to 45 years old, and English was not their first language. Each workshop took between 45-90 minutes. The participants were asked to find different images, first by using keywords in “Google Images” (2012), second by drawing in “unofficial Google search by drawing” (2011) and third by using the Iconic Search prototype. They were asked to explain their process, feelings, ideas and in general what they thought of the three different approaches.
The search process for each image/subject consisted of two parts. In the first part, they were asked to find an image which contained certain elements, such as:

- A room containing a double bed, television, lamp.

- A koala on a chair.

- A cat on a bench/chair near a tree.

In the second part, the participants were given an image as a starting point and asked to find another image with almost the same appearance (Figure 14). The starting images were found through online searches before the workshop, so it was possible to find these types of images through existing search engines. But because the subject matter of these images were relatively uncommon, it was difficult and time consuming to find similar looking image.

![Figure 14. In the second part users had to find images similar to these images.](image)

The users were given different images/topics to search for. The selected images were base on both their interests and subjects outside their interests. For example, one user who was interested in traveling was asked to find an image of the Eiffel Tower, but he also had to find a flower. Flowers were out of his field of interest and so he did not have much prior knowledge in this area.

To test whether users needed text descriptions for icons as an option to help them search for and find icons or have more information about icons, the icons of some categories, such as different kinds of flowers, did not contain the flower names. In the last part of the workshop the participants were asked
Iconic Search

to make a funny image from their own imagination. The purpose of this part was to see if Iconic Search could be used for making metaphors.

To avoid distracting the participants, instead of sitting next to them and observing what they were doing, the computer screen was recorded. There were also two cameras recording their face and movements. This approach also allowed the recordings to be reviewed at a later date.

8.3. Result of the First Workshop

The recorded videos helped to survey the details of the workshops. The participants’ description of their experience, their actions on screen, their facial movements and body movements provided different pieces of information. While some information was gathered from the participants’ verbal explanations, a lot of information was gained from their actions and movements. Examples of this were they spent a lot of efforts on a particular task, when they were struggling with their mouse, or when there were signs of anger or confusion in their face. This chapter describes the information gathered from the workshops.

8.3.1. Search by Text, Features and Problems

Users chose search by text as their preferred method when they were not looking for a specific image; when they just wanted “something” that satisfied their requirements. Users also found it useful for when they wanted an image for inspiration. “When you search by Google, by looking among all the pictures for few seconds you will find something similar to what you imagined, even something more interesting that is better than what you originally envisioned”.

However, they found search by text to be neither useful nor sufficient in terms of finding specific pictures or novel items. “Text is definitely the easiest way to search, but in some cases it is not sufficient and it does not help to find what you want. For example, you have seen something unknown [which you know by sight but not by name] somewhere and then you want to find it later”. They mentioned that as their requirements for an image increased, and although search by text resulted in plenty of images, the search results contained mostly pictures that do not satisfy their needs. “I got a lot, like hundreds of thousands of pictures and I go down..., but find nothing that matches”.

Words play a crucial role in searching by keyword. The users found it impossible to find an item, without knowing its name, such as a specific type of flower. “If I knew the name, I think I could find it easily”. “That is impossible to find it without knowing the name, I tried different words, but it doesn’t work”. Spelling mistakes were another issue with searching by text. Two of the users had spelling mistakes. Another issue was selecting appropriate words. For instance, using the phrase “cat in garden” helped to find picture of a cat on a chair, next to a tree, and other similar scenes, while combining “Cat”, “Chair” and “tree” separately did not result in a suitable image with this kind of composition.

Users said they wished they had an option to select the quality/resolution when searching for images. They also wanted to have the ability to select if their images were horizontal or vertical. “I want to have
the choice to say lie down or standing picture and I couldn’t find anywhere in Google where I can say that”.

8.3.2. Search by Drawing, Features and Problems

Users found search by drawing as the most complicated and time consuming method. They found it very hard to draw a copy of an image or draw something from their imagination with the mouse. Only one of the users started using the touchpad but he later asked for a mouse. Another user started using both of his hands on the mouse to control his drawing, “It is very difficult”. Participants also believed that what they drew did not look like what they had in mind (Figure 15). “It is more like a koala doll”, “It doesn’t look like the Eiffel Tower. I need to practice it more”.

As the time of process increased, the users started to refuse to do the drawing portion of the workshop. They mentioned “I want to search something. I don’t have time to waste to draw”. “You have to undo a lot of items, you have to change the color, etc lots of time. It almost makes the user nervous”. However one user mentioned that while drawing was really hard, it let her have the framing she wanted.

Furthermore, the search results were different from what the participants expected and the search engines often returned images with matching the same colors rather than matching items. This may be because the search engines used were prototypes themselves, but the result was not the main purpose of this workshop.

Figure 15. Images users defined by drawing.
8.3.3. Iconic Search, Features, Problems and Requirements

Users found Iconic Search easier than search by drawing because they could use existing picture icons and just had to place them in a scene. They also found it more useful than search by text, when they wanted to find a specific image or when they lacked knowledge about certain elements, like the name of a flower. “It was easier to find the flower [when you don’t know its name] in this way. At least I could see something [the icons] and see the name, but when I searched the [word] flower in Google, I couldn’t find that in all the flowers in result”. “I like that I can choose what kind of tree I want”. “It reminds me one story, when I found an otter nearby and I didn’t know the name in English. Maybe if I had a collection of clip arts of animals, then I could find the same animal”.

The users found the ability to define size, position and color as good features to describe what they had in mind (Figure16). “When I use this, I get the scaling right”. “It takes me more time, but I can define the image exactly as I want.”

![Figure16. Images users defined by using icons.](image)

The main difference was in terms of use cases and users. The designer and architect found Iconic Search very useful and helpful. They said it could potentially fill the gap they claimed to have felt many times when they were working on tasks or projects that required a lot of time spent searching for images. For instance, when they wanted to find a specific image to show to a client or company. On the other hand, the software and telecommunication engineers said they rarely looked for specific images online. They
preferred to use icons to have access to different kinds of information. For example, they said they would use an icon of a body organ, like a kidney, to connect them to online information related to the icon such as kidney diseases. They also found it useful for learning purposes such as learning different languages. The engineers believed that if the result contains only images, it can be helpful for designers, photographers, students or whoever works with images and photos a lot, but not necessarily common users.

The designer and architect, who found Iconic Search more useful, were asked to make a funny image with the icons for themselves. They did the task, but claimed it was meaningless for them. Afterwards it was explained to them that the purpose of the task was to see if they would use the icons as metaphors. But they still believed that this approach was not useful for them. However, they mentioned “maybe it can be useful for someone that prepares images and books for children or maybe for someone that makes posters for events/ceremonies, such as Halloween”.

All the participants seemed to be fine with the black and white icons. One of them mentioned “It helps me to scan the images easily with nothing, like quality and colors, to distract me”. However no one noticed that some categories did not contain the names of items. This suggested that they were looking at the icons and not the text. Yet they claimed to want to be able to search and find the icons easily and quickly, which shows that perhaps the text is still needed after all. Also the need for a “manageable” number of icons seemed to be a requirement, because while some participants believed that the number of available icons was limited, others believed that if the number of icons was too great, it would be time consuming and challenging to find and use them. We will try to find solutions for these complexities in further steps in the design process.

Some users even went beyond the tasks of the workshop and started to play with the idea of Iconic Search and try out some of their own ideas. One user started to color the icons. Another user uploaded his created images by icons to Google to see what the search results were. He also invented his own examples and ideas for search criteria, because he believed that some of the tasks were unique and difficult to find. And so he liked to see the results for simple images such as a very simple fish.

8.3.4. Conclusion and Moving Forward

In general the participants found Iconic Search to be a useful option to find specific images and objects they knew by sight but not by name. However, they believed that this method was not suitable for every subject, such as 3D models, abstractions, or inspirational images. In addition, they believed that this method would only be helpful if the process was simple and quick, and that the results satisfied their requirements.

The first workshop answered a number of questions. But the most important answer, which led to further development, was that according to the participants themselves Iconic Search could in fact be useful. This answer came from participants experiencing the way different search methods, including the prototype of Iconic Search, let users define their requirements. However, although the experience allowed users to have a rough idea about how Iconic Search could work, it was not a coherent prototype
and it was also not testable if the users were not familiar with Photoshop. Adding icons from a folder to Photoshop and editing them was challenging for the users that were not familiar with Photoshop and its hot-keys. More importantly, the users were not able to get any search results from their arrangement of icons, while it was possible to get search results from the other two methods. This could affect users’ opinions about the different search methods. The users were sometimes confused if they should define their requirements with Iconic Search separately and then add the image they composed to an online search engine. Therefore, after learning that Iconic Search could in fact be helpful for users, the next step was to make a better prototype, which let users have a better experience with the appearance, interface, functionality and result of this IR. This could also help to gain more knowledge about the usability of this method and find answers to new questions such as the appropriate number of icons, and the need for adding text to icons.
9. A Higher-Fidelity Prototype of Iconic Search

The second prototype was a quickly made software sketch of Iconic Search and aimed to help in introducing, communicating and experiencing Iconic Search’s functionality and features. (Löwgren, 2008)

This section explains the details of this prototype and the different aspects that it covers. It is worth noting that the role of users in improving the search engine and helping other users was not the focus of this prototype and will be discussed later in section 13.

9.1. Programming Language

The prototype was windows base and built with the C# programming language. This choice was due to basic familiarity with the language, which was helpful during the programming stage. I also made my own small database full of images from the internet. However, as the logic is the same across different programming languages, the final search engine could use other programming languages and databases such as PHP and MySQL.

9.2. Icons

The icons were black and white, the same as the icons in the previous prototype. The icons were arranged into five different categories that included animals, landscapes, trees, flowers and furniture. Each category contained ten icons. Underneath each icon was its name/title to assist users who did not know an icon by its name, such as certain types of trees, animals, and so on. The categories were arranged into labeled tabs.

9.3. Keywords

This prototype aimed to let users utilize some keywords, but the usage of keywords in this model differed from other IR’s that use keywords. In this model users could only define keywords for non-visual concepts, abstractions and in general what was not accessible through available icons. For example, users could type night, sustainable, sad, winter, addiction and dark, but not cat, dog, Eiffel, Rose or the names of the other available icons. The aim here was to go beyond the limitation that using icons alone could have. But because the icons for some subjects already existed and they already contained their own names, writing keywords for the existing icons seemed to be redundant.

9.4. Functionality

The define search requirements in this prototype, users start by double clicking on an icon or typing a keyword. Consider a user who is looking for cat images. By clicking on the cat icon, the icon is added to the search screen at a larger scale, and positioned on the left side of the screen. The user receives search results by clicking on the search button, and thumbnail results appear on the right side of the
page. By clicking each thumbnail, the user can see the image at its original size. This model let users define an image using several icons from different categories. The results are images that contain these icons. However this prototype, in contrast to the previous one, could not let users define the position, size or color of icons. When adding several icons in this prototype, they appear one after another in the search screen. The definition of size and position will be discussed later in section 14. Figure 17 - Figure 21 show some examples of search images in this prototype.

Figure 17. Results of searching for cat images by second prototype.
Figure 18. Users can see the original size of images by clicking on the thumbnails.

Figure 19. In this model users can define several icons, but cannot define their location, size or color. The icons are located one after each other.
Figure 20. Result of searching for cat and bed in second prototype.

Figure 21. Definition and result of searching for Paris in spring in second prototype.
10. The Second Workshop

10.1. One step back
In both the prototypes I used a computer because when users search in a real world situation they interact with a system and use digital materials, such as laptops and tablets. They also get a search result for their request, which is defined by the functionality and performance of the system. These reasons led me to build digital prototypes, which can almost let users have similar actions and reactions as they would with a real product. However, thinking about the issue that I was only trying digital materials raised several questions about my first workshops. What would the result be if the users were not using computers? What would the effect be on the second prototype and workshop? Therefore I decided to go one step back and try to find an alternative to a computer to show and test Iconic Search and other search methods.

This led me to an idea, what if we consider search engines as humans? This means that as search engine receives our requirements and retrieves results base on that, maybe we can consider it as a person that we explain something to. So I decided to introduce the search engine as an anonymous person, who the users would explain an image to through a variety of different methods.

To test this idea with users and also to see how users would react with the second prototype if they begin with defining a picture to a person, I decided to have two groups of participants in my second workshop. The first group consisted of the four users who participated in my previous workshop and tried different search methods. The second group consisted of new participants who did not know about the content of my thesis and the previous workshop. This means I could take that one step back and see, apart from computers and search engines, how could users transfer an image or visual content to another person who they could not make verbal contact with. This could also help reevaluate different search methods again and see if there are other features or alternatives that could complement or replace using icons. The first group would start by testing the prototype while the second group had an extra step before that which will be explained.

The workshop consisted of eight users on different days. The participants were from different fields of studies, were aged between 25 and 45 and English was not their first language. Their actions and results were captured on camera. To ensure users were not distracted and also to have the option to view their interactions with the prototype later, the screen of the computer was recorded. I was observing the users, guiding them and also asking different questions of them at different points. The participants were asked to participate in one or two steps that will be discussed in next section.

10.2. Part One: Explaining an Image to an Anonymous User
This part was only for the new participants. There were four notebooks that had different images on the cover (Figure 22). The users were asked to select one of the images; the reasoning for this was so they could start with an image they liked. Then it was explained to them that the image on the cover would be removed later, and they would need to explain it in a way that another person, who had not seen the
image, would be able to find it amongst a group of other pictures. The users were asked to explain it first with text (using words or sentences), second by drawing the picture and third by using icons which were available to them (Figure 23). There was a part after each method which asked users to explain their experience and also the advantages and disadvantages of using that method. Then the users were asked to compare the pros and cons of all three methods and explain which one they prefer. At the end some questions were asked about searching for images on the web. What kind of images do they usually look for? What kind of problems have they faced while searching for images? And what changes would they like to make?

![Figure 22. Images on the cover of notebooks.](image)

![Figure 23. Users can separate the icons and use them to define the image on the cover.](image)

The images were selected based on different criteria and also to answer specific questions. The images were varied to match the different categories of the prototype. For the text section, it was important to see how many words and what words the users chose for each image. For example, an image of a calla lily in a vase was selected to see what words the user would use to describe it, especially if the user did not know its name? Or in the images of the Eiffel Tower would they opt for short descriptions like “Eiffel in summer”, “Eiffel at day time” or would use longer descriptions? The focus in the drawing part of the experiment was to see how easy it was for users to draw and how much attention they paid to the details of the image. For instance, in the image of the Eiffel Tower in spring, which had many flowers and different types of trees in the picture, what would the users draw? Or how would the user feel when
drawing a cat, which might be more difficult to draw? In describing the image by icons, it was important to verify how the users interacted with icons. How much would they pay attention to the different types of trees and flowers and if the icons would be easy to recognize? Would they pay attention to the scales of the items? For example, in the image of the cat, would they question the lack of ability to select the scale or the direction in which the cat is faced? What would they do about the icons that do not exist, like a pillow, or the items that are not clear, like the types of flowers in front of the Eiffel Tower in spring? In addition, in describing the image by drawing or by using icons the users were limited to black and white colors which could be challenging for them, especially for flower and cat images.

10.3. Part two: Testing the Iconic Search Prototype

This part was for all the participants who were asked to test the prototype. First, the prototype and the way it works were introduced to them and they could spend as much time as they wished getting familiar with it and confident in how it worked. The aim of this part was to record the screen and later see how the users interacted with this prototype and how they discovered its’ functionality. Next, the users were asked to find images of different subjects that were written on cards. The subjects were selected base on different possibilities for how to evolve the prototype. The subjects consisted of:

- Images which contained one item, either something obvious like a cat or other items that the users might not be familiar with the name of, such as a hollyhock flower or a willow tree.
- Images that needed several icons, either from the same category like a picture of two cats or a picture of a cat and dog together, or images that needed icons that were from two different categories such as a cat in a bed.
- Images that there were no icons for and that users could only use keywords for, like cloudy weather.
- Images that needed a combination of icons and text, such as the Eiffel Tower at night or in spring.

In addition to testing the functionality and different possibilities of the prototype, there was another reason for having specific subjects that the user needed to search for. The reason was that the prototype did not contain images in the search result for all the possible combinations that users might search for. So having certain subjects would keep them in the right scope.

After finding images of the subjects that were written on the cards, the users were asked to define the four images on the covers of the notebooks by using different types of icons and/or keywords that they found appropriate.

At the end there was an open conversation with each user about different aspects related to Iconic Search, such as the advantages and disadvantages of this search method, different changes and improvements it required, how many problems the users faced while searching for images, and how much having the option to use Iconic Search could help them find their required images? They were also asked how often they might use Iconic Search? What do they think about black and white icons and also about the text description on each icon? How did they feel about combining text and icons, and the inability to write keywords for the items that already existed as icons?
11. Result of the Second Workshop

The workshops generated some very useful information. The users pointed out important issues about different aspects of searching for images and especially Iconic Search. The notebooks and prototype both were helpful in describing the idea, testing different aspects of it, and getting feedback. The users not only mentioned different features and problems of searching by icon, but also mentioned smart ways of changing and improving it. As it is not possible to mention all the information gathered from the workshop in this thesis, this section surveys the most important information in the domain of this thesis.

11.1. Result of Part One – Explaining an Image to an Anonymous User

11.1.1. Result of Describing the Image by Text

Users found it hard at times consuming to describe the image to another person with words. “By seeing an image, you receive a lot of information at once, but for describing it, you need more time to think and write”. “Sometimes you cannot explain everything through the words”. The user who was asked to find the image of a calla lily in a vase had a very difficult time, because she did not know the name of the flower or different parts of the flower in English. She started to describe it with different sentences, but she also did not know the names for different parts of the flower. “I don’t know the name of some of these parts even in my own language”. Finally she described it as: “It is a kind of flower... This flower is usually single. The shape is like egg with long yellow stem between them. It doesn’t have any smell”.

The difference in how users describe details of images was interesting to me. While one user explained the appearance of images in detail and mentioned the colors and even the direction that a cat was looking in, another user mainly used keywords to describe the main subject itself. This user believed that maybe the other person she was supposed to describe the image to did not know or remember the name of the “Eiffel Tower” so she described it using other words. Here are the words/sentences they used: “In the garden, a cat is sitting on the red pillow on the white chair. The cat is looking something in 45 degree angle down”, “Paris, big city, famous art piece (architectural), some say the ugliest world’s master piece, perspective- centralized photo composition”.

In addition, users had different priorities when describing the similar images. Two users described the pictures of the Eiffel Tower very differently. One user said, “The most important thing is the Eiffel Tower, otherwise it is just nature” while the other user explained it as “It is nature, full of colorful flowers and trees in the corner of the road, and the Eiffel Tower far away”.

However, the users believed that words can be useful in describing images, but mostly for people that have good English vocabulary or are good at explaining things in verbal or written form. The users mainly believed describing images by text was challenging and time consuming for them: “We see images and we live through them. It is by instinct; the perception is the key. It doesn’t need extra time or energy, while word takes more time”.
11.1.2. Result of Describing Image by Drawing

The users preferred explaining the images to the absent person by drawing more than with text (Figure 24). They believed that because they were using a visually composed drawing to describe another image, it was easier both for them to describe the image and also for another person to understand it: “It will make it easier for other people to visualize it”, “It is easier to draw than explain”, “It doesn’t need a lot of time that someone understands your meaning”.

Figure 24. Users’ descriptions of images by sketch.

However, the users mentioned several important problems in explaining an image by drawing.

- First, they believed that drawing is not realistic or interesting for all users: “It would be difficult if I don’t like to draw”, “I was drawing whole my life, so for me it was super easy, but I don’t think that would be applied for everybody”, “I am not good with perspective in images”.

- Second, the participants did not see drawing useful for all situations, subjects or items: “Now I had the image, but it would be hard if I wanted to draw from my imagination. Then you should have the details in back of your head”, “I don’t see it useful if I have an image of a person! How should I draw that?”.

- Third, the users were not sure if what they have drawn is clear enough or not: “If the other person can understand it is the Eiffel Tower, then I am a painter!”, “I might lead the viewers to misunderstand about the image by my drawing”, “It is just a sketch, I don’t think the other person can understand what I have drawn”.

- Fourth, the participants believed that the benefit of using text was that they could write about everything, but there are some limitations in drawing, especially when it comes to feelings and emotions: “It is not good for showing your feeling”.

In this portion, like when describing images with text, users had different priorities in their drawings, which was interesting to me. One of the participants drew almost everything in detail, even drawing
shadows to show grass. In contrast, another user drew a simple sketch: “I just used few lines”. Some users added or removed certain sections in their drawing. For example, for the picture of the calla lily in a vase, the user did not draw the vase, but instead drew two leaves for the flower. For the picture of the cat on a pillow on a chair, the participant added two trees, which were off in the background of the image and blurred out. This user also drew a mouse (which did not exist in the image) in the location that the cat was looking towards. In addition, the first two users mentioned above drew a frame first and almost had the scaling correct, while the other two drew at different scales and positions in their images. These different details in drawing reminded me of the problems mentioned for search by drawing in the section 4.2.2 that the users usually draw the parts of the image that are interesting for them, which might not be the important ones for retrieving images.

11.1.3. The Result of Describing Image by Icons

Three of the four users saw using icons as the easiest way for describing the images (Figure 25). First, because it was visual, but in contrast to drawing, did not need skills and was not time consuming: “I really like that it is visual. Drawing is visual too, but it is hard to draw, and it also takes time”, “You can describe the image easier than words or drawing”, “The easiest of all, even those who do not draw can do this”. Second, because they saw it as being clear for both describer and viewer: “Icons can communicate directly to the image”, “It supports your perception”, “It is easy to navigate for all”.

![Figure 25. Users' description of images by icons.](image)

However, there were three major issues in using icons:

- The first issue was about the user who was describing the calla lily in the vase. This user believed using icons was harder than drawing. Her perception could be due to my answer to her question, which I will explain here. First she added an icon of a calla lily flower at the left side of the page and asked me if she was done. I explained that it is up to her; she could be done or she could add other icons if she wanted. Because of my response I expected her to add a vase or say
something about her image or how she would show the vase in the picture which was not complete. Surprisingly she added an icon for a sunflower: “This one looks more like a flower to me. I think the icon of calla lily doesn’t really show it is a flower”. Then she added an icon of a daffodil next to the sunflower: “Now I can show it is a yellow flower”. She then repositioned the calla lily below the other two flowers and drew a mark from sunflower and daffodil to the calla lily to show that it was an explanation.

- The second issue was about the other three images and how the users described trees and flowers. None of the users paid attention to the different types of flowers and trees, and instead just selected whatever plant icon suited them. This might be because they were not the most important part of the images: “I don’t think there was any rose in the image but since it is a flower, it is OK”.

- Third, and something similar to the drawing portion, one of the most important problems was in describing feelings and emotions: “Icons can’t have much emotion to tell”.

In addition, almost all the users believed that the available icons were not enough to describe the images: “Not all the elements were present so explanation is not complete, but maybe enough”. No one argued about the scales or, for example, about the direction the cat icon was facing. With the exception of the one user who placed the calla lily below the other two flowers, the other users placed the icons in the appropriate locations.

11.1.4. Comparison and Combination of Different Methods

In general, this is how the users compared the three ways of describing an image:

- Words: Hard to explain some subjects, insufficient for items that the users does not know the name of [in English], and time consuming. However, words were broad enough to describe many topics and feelings.
- Drawing: Hard to draw, not useful for all users and subjects, not always clear for the viewer, and it is not really possible to draw feelings and emotions. However, drawing was visual, easier to understand and needed less time to create or to understand the drawing.
- Icons: Not enough icons to describe every situation, hard to explain details, and it is not really possible to describe feeling and emotion. However, icons were visual so they were easier to understand, they were fastest and easiest to define an image with, and useful for most users without the need for extra skills.

Another important difference came from watching the recorded videos. I noticed that while the users were describing the image, either with words, drawing, or icons, they looked at the image many times, almost after each sentence/word, each part of drawing or each icon. This could mean the participants were not referring to their imagination about what they saw, but instead referred back to the image again for more information. The most interesting element in their processes was the number of times they edited their descriptions by erasing the words, erasing the drawings or replacing the icons. Drawing had the most number of edits; one of the users used the eraser 27 times while she was drawing. Text had the second highest number of edits; the same participant used the eraser 4 times while writing. The lowest amount of edits was for using icons; two users replaced their icons and said sentences like: “Oh,
the flower is at the other side”. The number of edits also corresponded to the number of times users looked back at the image. Although this is not an exact pattern and cannot be applied for all users and subjects, this roughly shows the number of undoes/edits that users might perform when searching for similar images using these methods.

After describing the advantages and disadvantages of each method, the users were allowed to go back to any of their explanations and add whatever they wanted from the other methods of describing an image. This meant they could combine text, icons and words to have the most descriptive explanation. One user went back to her illustration of the Eiffel Tower and added the word “grass” in the location she added shadows for grass. Another user went back to her icons of the sunflower, daffodil and calla lily and added a description about why she had added the other two flowers. The rest of the participants did not change anything, but they mentioned that the method they preferred to use depended on the type of image that they were looking for, and that in general they wanted to have visual and text together. “I liked to combine all three methods, first use word, then icon and if required drawing”. “Drawing had some challenges, so I liked to combine text and icons. And I want to have this option to add icons for the things that don’t exist”. As a result, three of the four users favored the combination of icons and words, which could be evidence to support that showing icons and words together for the second prototype was an appropriate decision.

11.1.5. Searching for Images Online, Challenges and Gaps

After the previous steps, I explained to the participants the tasks of notebooks aimed to resemble different options assist users when searching for images online. Three of the four users agreed that it was similar to their online experiences and explained different problems they experienced while searching for images on the web:

- “It [problem with keywords] happens especially when I don’t know how to describe what I am looking for”;

- “Sometimes I don’t choose the right word so I can’t find the image that I want. When I change the keywords I will find the right one. It is really dependent on the keyword that I use”;

- “I usually find the name/word in the Google translate and then use it”;

- “It has happened a lot that I have a picture, and I wanted to know more about it. For example, I see a plant or flower and I don’t know how to put the name. I can’t just write flower; I should know the name otherwise I can’t find the picture”;

- “If you put all the words that you require you just get nothing in the existing search engines. If I write the Eiffel Tower, perspective and quality the result is as if I am confused, what are you looking for? Then you have two options: 1- buy it from the websites that sell the pictures 2- First find the subject, then look for images with better qualities."
- “If I don’t know the name then I have to start with something and then it is a nightmare to find it among all those images. It would be the same for this picture of cat on a chair, because there are lots of cat images on the web”;

- “I can’t define vertical, horizontal or some other details when searching, so I find an image and then edit it in editing tools”

However, the user who had the picture of the calla lily in a vase, believed that explaining an image to a person is completely different than describing it to a computer. She said she never had a problem while searching for images online and if she needed to search for such an image, she would search for “flowers” and then would find the image amongst the results.

In contrast to the user responses from the first workshops, these participants said that misspelling was not a problem because Google would suggest the correct word for them.

11.2. Result of Part Two: Testing the Iconic Search Prototype

With the first portion of the workshop done, users then moved onto the second section where they tested out the Iconic Search prototype running on a computer. I started testing the prototype with roughly three users who had negative views about using icons (the computer and telecommunication engineers from the previous workshops and the user who had the calla lily in a vase) and five other users who were either positive or neutral about using icons. The final result after testing the prototype changed people’s perceptions so that all the participants saw using icons not as the best option for search in general, or a tool for all users or all the subjects as I expected, but as an option that they saw useful in helping to find images that were difficult to find using regular search engines. Although the users were from different fields of studies, were new to Iconic Search and IR’s, and tried the prototype for less than 30 minutes, they got the concept really fast, and commented on different features, possibilities and gaps. They also came up with smart ideas for changing and improving Iconic Search. The participants believed that applying some of their suggested features could make a really good search engine that contained the necessary options and could satisfy their requirements.

11.2.1. Search Images by the Prototype

To test the Iconic Search prototype, users were asked to find images of different subjects that were written on cards. The subjects included images that contained one image like a cat, images that need several icons like a cat and a dog, images that there were no icons for so participants had to use keywords, and images that needed a combination of icons and text. When users saw the subjects on the cards they mostly said they did not know what a hollyhock flower or a willow tree was, but this did not cause any problems because when they started searching for images they found hollyhock flower and willow tree by the descriptions of icons. The users could almost find all the subjects on the card. There were only two exceptions. First, one of the users completely forgot about using keywords, she kept using icons for the subjects that needed keywords. For example, she used the Big Ben icon for cloudy weather, because London is famous for its cloudy weather. She also tested different icons of flowers for a picture of the Eiffel Tower in spring: “I think these flowers grow in spring”. She later mentioned that the reason she forgot about adding keyword was that in the layout of the prototype the text input
section was not near the icons but instead was located under the search area at the bottom of the screen.

The second exception was about finding images of cloudy weather, which was challenging for all the users and almost made two of the participants angry. The problem was because of my mistake in both explaining how the keywords worked and also in selecting the keyword in the database. When I was writing the code for the prototype, I wanted to test if users could just write one keyword for their explanations. The first mistake was about me selecting one keyword for “cloudy weather” images in the database. I added “cloud” and “cloudy” for that subject, but logically I should have also added the word “weather”. This could have let the users look at different types of weather because cloudy would be an adjective and I should not have kept the adjective in the database and removed the noun. The second mistake was that I had the label “Add keyword...” next to the textbox. I did not have any emphasis on “one word,” neither in the prototype nor during on my explanation. These mistakes led two users to think there was something wrong with their spelling. However, although this subject was challenging for all the participants, everybody found it after trying a few words.

11.2.2. Positive Features and Advantages
In general, the participants were very positive about this method of searching for images.

- First, they really liked that it was visual: “It makes a better connection with your brain and imagination”.
- Second, they believed that having icons can prevent some problems when searching for images: “When I write a word for search, the first thing I see is images of famous brands with that name. If I use the icon instead, I can prevent that. It is also same for the words that have different meanings.”
- Third, they said it was very easy to navigate and work with: “If you want to have a picture of cat and dog, by just clicking on them, you can see different pictures of these animals together. It saves your time, and you reach the image that you want easily”, “This is easy to navigate. I just needed to get used to it, but it only took few minutes”.
- Fourth, the participants believed that having both text and icon was very helpful, and that they complementing each other: “Sometimes you have a picture with a brief sentence for it and it can be helpful especially for the images that you couldn’t explain by icons”, “I don’t know how different types of trees are called. If I need a particular tree and I know how it visually looks, I can find it and combine it with text about weather or times of the year”.
- Fifth, the participants thought the descriptions for icons were helpful, especially for different types of trees and flowers: “It is helpful, particularly for trees or flowers because you don’t always know their name. Maybe their appearance or smell but not the name”, “You can use the descriptions if you want, but it is still visual”. One of the users found “any kind” item in trees category, and she saw it very useful to have general icons for when you don’t look for specific types.

Except for one user who preferred to have colorful images instead of icons, the others were fine with black and white icons: “It is good enough. You are not searching for the appearance of icon; it helps you
to show your subject for all different kinds of images like photos, clip-arts, etc.” In addition, one of the users saw having a frame as a very good feature: “Just having a frame is an advantage, even if you just can say vertical or horizontal”.

11.2.3. Problematic Features, Requirements and Improvements
The users mentioned important problems and requirements not only about using icons, but also about searching for images in general. It was interesting to see that some of their ideas were really close to what I had in mind when I started work on this thesis, which was a positive sign for me and supported the idea that there is really a need and a use case for those features. There were also many ideas that I would never have thought about, as I had my main focus on using icons and not the other features and options that a search engine could contain. The feedback from users provided a rich source for future steps. As it is not possible to mention all the information in details, I will explain the most important ones below.

First, the users did not want to have any limitation when using text. For example, they wanted to have the ability to add keywords for the number of items they were searching for: “I had to add two icons of cat for the image of two cats. What if I want to look for 100 cats? I prefer to write the number”. The participants wanted to be able to write keywords even for the items for which icons existed: “When I am familiar with the name of something I don’t need to spend time, find it between many icons and add it”. “Writing word is in general the easiest and fastest, when I am not looking for specific images there is no need to use icons”. “I might want to look for wild animals, then I don’t like to add the animals one by one and search for them. I want to have them in one search”.

Second, the main concern of users was about having too many icons in a real search engine: “Now there are few icons in each tab, but there are lots of animals, trees, flowers, etc in the world. Then I think it is a challenge to find what I need between 100 icons”. Almost all the participants mentioned this issue and some asked if I knew how users should deal with this problem. I knew about this problem but I did not have a solution for it. Three of the users suggested some useful solutions: “Maybe there should be two, basic and advanced, modes. So base on your requirement, you can choose one. Sometimes I might need a photo with common items in it, let’s say animals that everybody knows and are common to search. Maybe I can just use icons and I even don’t need keywords (Or the other way around), then I can use the simple mode. In contrast, I might look for a specific type of animal. Here, I use the advanced mode, then it worth to look at many icons”. Another user wanted to have some options that could help to limit the number of icons: “Maybe I can have a map. Then I could say animals from this area”. Another user wanted to have some kind of search, sort or complementary for icons: “Maybe I can have a search for the icon that I want. For example if I write “Ei” it shows “Eiffel” and other icons that start with “Ei”. Something like what Google has but both icon and text. Or maybe I can have different kinds of sort or search. For example, I can sort a category by alphabets, by colors, etc”.

Third, the users wanted to add more information about each item or about the whole image. Color, frame and quality/resolution were some of the most important features for them: “I want to be possible to add color for icon and background”. “We only have white and yellow calla lily in my country but there are more colors of that. When I want to add this flower I want to see what the different colors that I can
select are”. “Usually the pictures of landscapes are horizontal. Then it is a challenge to go through all images and find vertical ones. It would be so helpful to have an option to select vertical/horizontal”. “Like the options that Google has for different sizes or colors, I like to have an option for different qualities”.

Fourth, two of the participants talked about the possibility of positioning and resizing the icons: “I think this search would be mainly useful for artists and designers. So I think it should be more than this and let users move the items, resize them and maybe show the angle, as well. For example, I was looking for pictures of cups on the table, but from the top view. If such a search existed, I could add the icons of cup and table and set the view to top”. “I want to say how small or big I want my items”. As having these options was part of my idea as well, I also asked other users about it. Two of them thought this would be rarely used, but the others said they would like to have this option: “Then I can just move the stuff and see what I will get. It might also help to get a picture that I don’t expect”.

Fifth, one user discussed sharing images between people and gathering images from them. This idea was very similar to what I had in mind about the role of people in Iconic Search. She mentioned: “I study biology and there are many mechanism and molecules that are not easy to understand by reading text. Then I should find images of that to understand it, but sometimes I don’t find the images online so ask other people to send me the images. If people in different fields of study put icons and images from their information, then it will be huge information, like Wikipedia, because everybody can add data and it would be a complementary to whole data”.

Sixth, the participants had several comments about the content and also the layout: “Now there are just icons for beautiful things! There isn't any icon for educational purposes and also different fields like biology, physic, art, etc”. “The location of buttons needs to be changed, the top part of the page looks fine, but the bottom needs more arrangement and maybe some changes in labels and sizes”. “The warning messages are annoying. Instead of showing pop-ups for no result, it can just show a label with “no result”.” I can understand that; I don’t need to press “Ok” button of pop-up to confirm that”.

Seventh, the users discussed features that complement their search and also support their aim. These can be grouped into five main features:

- Feature 1 | The ability to edit and complete the search: “Now in this prototype when I search something I can't edit it, remove some parts or add to it. I have to restart the search. I want to have the possibility to edit it. It's annoying if I want to start from the beginning for each change”.

- Feature 2 | The ability to collect and compare images: “I want to keep my result and compare that with other searches. Imagine I want to find an image for a fast-food. I search for “hamburger” and see different images. Then I also want to see images of “fried chicken” and see which one is better for my purpose. Then I like to have this option to collect the images that were best in two searches in one place and compare them”. Another participant had an example from the field of biology: “There are different images of a kidney. It can be a picture which
describes different parts or it can be a scan of that. When I want to use both of these images together, I need to find the ones that look similar. So I need to compare them”.

- Feature 3 | Marking favorite images: “I want to add the images that I prefer to my favorite images. So I can refer to them at any time”. Although this idea might need unique user accounts, it helps users to always have access to their favorite search results from any devices without the need of using extra software.

- Feature 4 | Suggestions base on previous searches: “For example, if I search for the Eiffel Tower then it shows suggestions like other buildings or landmarks from 18th century or the ones that are from metal. Or if I search for two landmarks in France it suggests me other landmarks in France”. “I think the suggestions should be like what you have in your tabs, combination of icon and text”.

- Feature 5 | Item priority: This was also mentioned in section 11.1.1. One of the users who was describing the image of the Eiffel Tower talked about priority. She saw it as being useful to define the priority of the different elements that get added to a search: “I can say which one is the most important one in the image. It can also count the first added icon as the most priority, the second one as less and so on”.

11.2.4. User Groups and Use Cases

The participants had different ideas about which user groups this search method could be useful for. Some saw it as useful for everyone: “If you are particularly good in something then you would probably know the words, the names, descriptions and other things for that. So it is generally useful for everybody, for the fields that they are not good in that”.

However, some saw this method as useful for specific user groups. One user defined visual people as the main users: “I am a visual person. I think it is for people that don’t think with words”. Some believed that it was good for different fields in design “Like designers, architects, web designers” or other people who work with images a lot, “Photographers, artists”. Some participants suggested people who are not familiar with English or children who have not learned reading or writing yet: “It can be really interesting for children. I can see my nephew sit and play with it”. Older and disabled people also were mentioned by two different users: “Maybe the older people that don’t remember very well or are not used to internet and search stuff.”

It is also worth noting that using this search method depends on the type of image that the user is looking for. “If I want to buy a car, then I don’t use icons. I just search the model of the car by words to see different images of that”.

In addition to seeing Iconic Search as useful when searching for images online, the users expanded potential use cases to include a mobile application and shopping centers: “It could be really helpful if it was as a mobile app, because it is a small screen so you don’t have enough space or good size to write
so many things. It is hard to write when it is a touch screen, as well. Then for the example of cat in bed you tap on animal, tap on cat, then tap on furniture and then tap on bed. So instead of writing “Cat in bed” you just have four taps”. The users also found it useful for shopping purposes and shopping centers: “Maybe when you go to a shopping center search what you want, like a certain lamp by its icon and see where you can find it. Or the other way around, maybe you can search an item to see what shopping centers have it”. 
12. Visual and Textual Features and Needs

Talking about visual people in the workshops added another aspect to the idea of Iconic Search. It brought up this notion that in addition to Browsers, Searchers and Surfers as users, Iconic search has other types of users who are visual thinkers/learners who do not think with words. Thinking and communicating visually is not something new. It started before the invention of words, when people were communicating through signs and symbols. The examples of early signs and symbols can be seen in cave paintings, where people were using them as a form of communication, as maps and astronomical markers, or as part of religious ceremonies (Hampshire and Stephenson, 2008). One could argue that people were using signs and symbols because words had not been invented yet, but having visuals before words is not only part of history, but also part of our childhood: "seeing comes before words. The child looks and recognizes before it can speak" (Berger, 1972). Apart from history and childhood, it is also part of our everyday life, as one of the participants of second workshop mentioned:"you see images around you as you open your eyes in the morning".

The difference between visuals and text is not only in when or how much we use them, but also in how much data they contain and transfer. Although we can describe a scene with words, it is still incomplete and do not fully transfer the sight we have seen. For example, when we explain a sunset, there are many details that words cannot explain. That is why many of us have heard the sentence, "A picture is worth a thousand words".

Considering all the above, there are many examples to point to where visuals have been strongly favored over words. Here I explain three examples that are more relevant to the topic of this thesis. The first example which is fully visual is from the book "Ways of Seeing" (Berger, 1972) in which some of the chapters contain only images with no descriptions (Figure 26). The purpose here is to let the viewer get information from the images themselves and not limit or change the viewers’ ideas by adding words to the images.
The second example which is mainly visual is the Pinterest (2012) website in which people can share their collections of images (Figure 27). To me, Pinterest looks like a [more] visual version of Twitter (2012) and Facebook (2012).

The third example is the Google Image Dictionary which is a new concept and is not yet printed (Figure 28). This example is also fully visual. The dictionary contains 21,000 images instead of the words that
regular dictionaries contain. The selected image for each title is the first image that comes up for each word in a Google Image Search.

![Google Image Dictionary]

**Figure 28. Google Image Dictionary.**

However, regardless of whether users are visual or not, there are some subjects where it is not really possible to use words and visuals as alternatives to each other. This means, some subjects might only be explainable by text, some only by visuals, and some might need the combination of both. The situation also varies for different combinations of visuals and text. This can clearly be seen in one example from the book "Ways of Seeing" (Berger, 1972). In this example, the book asks the reader to look at the image in Figure 29 for few minutes before looking at the rest of the text.

![Wheatfield with Crows by Vincent van Gogh]

**Figure 29.**
In the next section, the book describes that this is the last painting by Van Ghog before his death. This notion affects the way the viewer sees the image and leads to a different interpretation of the image.

All the examples mentioned in this section try to show that both people and the subjects they search for are different and complex, so users need different tools and features which match their needs for search. This also confirms that ignoring the use of text or limiting certain use cases, like using one keyword or using keyword for non-visual subjects, which happened in first and second workshops, were decisions that should be changes. People should have the possibility to use the amount of text and visuals that they want. This combination can let different types of users search for different subjects based on their own preference, needs and wants.
13. The Role of People in Iconic Search

It was not so long ago when internet users were limited to seeing only the information that they could find on their own. This changed as digital systems went beyond only serving information, and started processing users’ social interactions and using this to provide further value (Erickson 2011). To explain this change, we can refer to social computing which is about how digital systems support online social interactions (Erickson 2011). Social interactions can be categorized in two groups: The first group are the more obvious social interactions like when we send emails to colleagues, chat with friends, share images with family members, etc. The second group is the social interactions that are not so obvious because we do not interact with people directly, but we instead affect their information or process. In these situations we usually do not know the people that we are affecting. Adding and editing information in Wikipedia and rating books on Amazon are examples of this (Erickson 2011). In this second group the digital system is using and displaying the user provided information in search results that the same user or other users have access to. “[...] digital systems began to process user-generated content and make use of it for their own purposes – which often involved producing new functionality and value for their users” (Erickson 2011). This section surveys this social aspect of Iconic Search and its benefits.

As mentioned previously, one of the main differences between Iconic Search and current search engines is the role of people. It aims to:

- First, let people improve the database of images by adding different images and tagging the items, icons and subjects that the images contain.
- Second, let people help each other in finding images. This means, if a user cannot find an appropriate image for his search, he can keep his search as request and inform others about it. Then other users can see the requested image and if they have any image that matches it, they can upload their image as a response to the request.

This chapter will explore these two features in more details.

13.1. The Role of people in Improving Image Database

Nowadays, we can see many examples that contain and utilize human generated information. Flickr (2012), a photo sharing platform and Youtube (2012), a video sharing platform, are two well known examples of this. Flickr, which aimed to provide a context of interaction instead of an application (Shuen, 2008), has more than 2 million registered active users. These users uploaded more than 100 million photos, 80% of which are publicly accessible through the Flickr photo database (Shuen, 2008). Flickr is a good example of how people can improve a database and provide a good platform for others to use. Flickr especially helped photographers introduce themselves to larger groups of people and to the whole world.

While the aim of Iconic Search is quite different from Flickr, it has many similarities, which shows the need for having people as providers:
First of all, Iconic Search is about searching for images, photos, pictures, sketches, etc. Even if we just consider photographs, each person who own a digital camera can be thought of as a little library of unique images that he has taken. Therefore, if all these images were available to be uploaded and shared it would mean the addition of lots of images to the pool of searchable images.

Second, Iconic Search uses metadata for search queries. When users tag the text and icons that an image contains, they not only improve the metadata and database, but they also add their point of view to the images. And so user’s metadata might differ from what a search engine adds itself. For example, a search engine might add the words “black” and “cat” for an image of a black cat, while a user might see it as a scary kitten.

Third, having people as providers can let the interested users add and share their information and knowledge. In Iconic Search, and in contrast to what some Flickr users might assume, it is not important to have the best looking shot. Instead it is important to have any type of photo or picture that might be useful for another person; whether that picture might be a beautiful and fancy photograph or an academic picture from the field of biology.

While Iconic Search aims to allow users to upload their own images and tag items that it contains, it should let users add the images that they have uploaded in other platforms, such as Flickr (2012), Picasa (2012), SmugMug (2012), Webshots (2012), Shutterfly (2012), Photo.net (2012), etc. The reason is that there are already many images that are uploaded and tagged by users which can be used. By adding the images that users have added in other platforms, all the images will be gathered in one place to be used for search.

In Iconic Search, much like with Wikipedia which has user generated information, lots of useful images are gathered from different uses, content sources, field of study, and so on. Selecting the best and most relevant images could be supported by different methods such as rankings base on the number of clicks an image receives, or the number of times it was used. It can also be done by some sort of verification from the system or users. When users upload images, copy rights and terms and conditions also play a crucial role. When selecting appropriate pictures, copy rights and terms and conditions each are broad topics and need more research, and so they are out of the scope and time of this thesis.

While having user generated information helps in improving the database and transforming the role of people from only viewers and users of images to providers of images, it also provides a platform for helping other users in finding their required images. In other words, it provides an indirect method of communication between the users. More details about this interaction between users will be discussed in next section.

13.2. Role of People in Sharing Images

It might have happened to many of us that we needed to borrow a book from a friend or ask for a copy of e-book. It was because we needed some information that we did not have ourselves. The situation might be the same for images. Although the invention of scanners and digital cameras has provided many copies of images and photographs and has also removed the time and location limitation that users had before, still there are many images and photographs that are not accessible to everyone. One
reason might be because the person who needs the picture is not aware that somebody might have an image(s) that matches his requirements. The owner is not aware that somebody needs his image. But even if the owner knows, there is not always an appropriate way that they can find the other person and interact with each other.

One example of needing an image and asking for it could be the participant of the second workshop who had difficulty in finding images in the field of biology. She said she usually asked her friends to send her images that she could not find online. In this example she was limited to class mates or peers and the question here is, why is it not possible to have access to more people?

One could argue that why would some people spend time checking for user-requested images and upload an image as response? To answer this question I would like to refer to different forums in which people can ask their questions and get some help and response from others. From these forums we see that there are many people that like to share their information and help others, and there are available platforms to let them do so. That is what is also required for images; a platform that lets a person explain his requirements for an image and allow others to upload an image as response.

Iconic Search aims to provide an appropriate platform for this purpose. On the one hand, it lets people describe their requirements in detail by adding icons, text, and setting the icon size, position, etc; so a user can show others how the image that he needs look like. On the other hand, it let users upload images, so they can upload an image that matches the stated requirements. The combination of these features lets users ask for the image that they need and actually get it. In other words the users can indirectly interact with each other and share images through a mainly visual language and platform.

To avoid disturbing users, these requests would be located in a different section of the application. To request an image from more relevant users and make a more sufficient platform for volunteers, it should be possible to find requests base on the icons that are added. For example, a volunteer who has pictures of ladders could search for ladders and will see the requested images that have tagged with ladders.
14. How to Get the Approximations That Are Requested From the Database

In this thesis we discussed that Iconic search aims to let users define an approximation of the image that they require, and get a result that matches it. This section surveys how it is technically possible to retrieve the size and position of items in these approximations.

When requesting an image from a search engine, three elements are involved. First, the layout in which users can define their requirements and the described request. Second, the query that transfers the requirements to the database. Third, the database, where the information is stored.

To retrieve the image that a user has requested, the information in user’s request should match with the information in the database. Therefore, the same level of information in both the request and the database is required. I will explain this more below. When searching by Iconic Search, on the one hand we have requests from users that are associated with two kinds of descriptors. First, textual information that defines subjects and items. Second, visual information that defines items and their arrangements in the image (Petraglia, Sebillo, Tucci and Tortora, 2001). On the other hand, we have images and their information in the database. To match the information from a request with the information in the database we must have the same textual and pictorial information of the image in the database.

There is no real technical concern about textual information, because this can simply be added as metadata to the database, but the pictorial information of the image must be translated into a language that is understandable for the database. If we consider an image, it consists of two types of information: information about the objects that it contains and information about the size and spatial arrangement of visual elements (Petraglia, Sebillo, Tucci and Tortora, 2001). So, there should be a structure that stores this spatial information that is embedded in the image, in the database.

This is when iconic indexing methodology enables us to use icons as indexes for pictorial information: “The index of an image is an iconic image itself, which represents the visual information contained in the image in a form suitable for different levels of abstraction and management” (Petraglia, Sebillo, Tucci and Tortora, 2001). It is then a “symbolic projection”, one of the iconic indexing methodologies, which lets the system translate the spatial information of the image to a two dimension (2D) plane (Petraglia, Sebillo, Tucci and Tortora, 2001). The 2D information lets the system create an iconic index called a 2D string, which is derived from projecting the objects of the symbolic picture along the x- and y- directions. This 2D string, which contains the information about the objects and their arrangements, can be preserved in the database making it possible to match the 2D information requested by users with 2D information that exist in the database.

To see how the objects and their relations can be translated into symbolic projections and then 2D strings, let us first consider two objects, A and B, and see how they can be located in one dimension. Figure 30 shows all possible relations that they can have to each other.
These relations can be stored in a system by a set of spatial operators defined for this goal (Figure 31).

Now let us survey how it works for an image. The iconic indexing first transfers an image in symbolic form. This means that instead of the objects being in the image, there would be shapes (squares, rectangles, circles) with almost the same size (Figure 32).
The iconic indexing then translates the information of the symbolic image in a 2D string based on the location of items in the $x$- and $y$- dimensions. This 2D string can be preserved and used in the database (Petraglia, Sebillo, Tucci and Tortora, 2001):

$$\text{Ob} = \{ A, B, C, D, E, F \} ;$$

$$\text{Relx} = \{A<B, A<C, A<F, A<E, A<D, B/C, B<F, B<E, B<D, C<F, C<E, C<D, F|D, F%E, E<D\}$$

$$\text{Rely} = \{A/B, A<C, A<D, A<E, A<F, B<C, B<D, B<E, B<F, C<D, C<E, C<F, F<D, D%E, F<E\}.$$  

It is possible for iconic indexing to have the exact location of the items as well. For example for Figure33 we will have: \([abc, (1,1)(2,2), (3,3)(4,4), (5,2)(6,4)]\).
When users define their requirements, the same indexing method transfers their 2D iconic request to a 2D strings. The user request matches with the information in the database and the appropriate images will be retrieved as search results.

After the search engine found the images that match with users requirements, it can also use Visual Memex (Shrivastava, Malisiewicz, Gupta and Efros, 2011) (Shrivastava, 2011) to find images that have visual similarity with requested image, which are globally located on the net. This helps the search engine to goes beyond the images that are locate in the database and also finds similar images in different seasons, lights and visual domains such as sketches, paintings, photographs and so on.

There are also two important factors in retrieving the information, which should be considered and supported as well. First, there might be images that are similar to what the user requested, with some differences in objects, locations of objects or arrangements. This is possible through “Values of Similarity” (Petraglia, Sebillo, Tucci and Tortora, 2001). Second, the search engine should have the ability to retrieve the images that are mirrors of what the user has requested. This can be done by some algorithms for mirroring the information. The details about these algorithms are out of the scope of this thesis.

Because of time constraints I was not able to test this feature with users. But it could be part of some future work.
15. Future of Iconic Search

Since Iconic Search aims to provide a better communication and interaction between the user and search engine, it is important to design conditions for pliability (Löwgren, 2007). “The use of a digital artifact is characterized as pliable if it feels like a tightly connected loop between eye and hand, between action and response” (Löwgren, 2007). Searching for images by using icons was an attempt to provide pliability to what users require for both defining their search requirements and functionality, and considered the issues they mentioned during the workshops.

Base on my own ideas and what users explained in the workshops, there are four possible future-works for Iconic Search: Iconic search for computers and tablets, Iconic Search on mobile phones, Iconic search for shopping centers and Iconic Search for personal collections. Since the main concept can easily apply to all of them, I do not see them as different ideas, but instead as the options that can be used separately or as complementary. The main focus of this thesis and also this section is with the first option for future work. Information about the other three options can be found in (18.2. Appendix B).

It is not possible to say at this point how a search engine should or would exactly work or look like in the future. There are so many details that need to be tested and discussed. Therefore, I will explain a few rough ideas about its layout and functionality.

15.1. Iconic Search on Computers and Tablets

15.1.1. Iconic Search in Simple and Advanced Modes

When Iconic Search tries to let people describe their needs in an image through a simple process, it should match with the level of requirements that users have. As mentioned previously in section 2.2, different users search for different kinds of images based on their interests, needs and available time. While finding some images requires adding more details or including specific subjects or items, other images can be found with just a few common words or icons. To explain this more, let’s consider two examples that users mentioned in the workshops.

The first example is a user who wants to find an image of a cup viewed from the top. What might not be very important for him is what the cup looks likes exactly, but instead how the overall image looks. He might want to look at a cup viewed from the top regardless of its shape, size, color, etc. So for him, a generic icon of a cup which resembles many different types of cups could be enough to lead him to what he wants.

The second example is a user who has seen an otter and does not know the name of it in English. He is in a foreign country and wants to tell other people which animal he has seen. What is important for him is to find the exact animal. Therefore, having an icon of an animal, which is a generic symbol for many or similar types of animals is not enough for him. Instead, he needs to look at different types of animals to find the right one.
The requirements of these two users are examples of different layers of details that might be required. The difference in level of details could even be the same in one category; for example, looking for images of a cat compared with images of a Doll-Faced Persian cat. The difference here is base on the intent of the user, which was mentioned in section 2.2 where users were categorized as Browsers, Searchers and Surfers. The question here is what is an adequate level of detail for each category that satisfies all the different users? Should each category be limited by some number of icons? If the answer is yes, then how many icons for each type? And, which details should remain and which should not?

If we remove some icons out of each category, how can we support different types of users? Is not one of the most important features of a search engine to have a complete database? There are many IR’s that can support Browsers. But what is important in Iconic Search is also to support users with more and detailed requirements, and having a wide range of icons is required for that. However, if we include all possible icons, how could a user find an icon amongst all these icons? The problem here is if we remove some icons then some users, especially Searchers and Surfers, might not find what they want, like a specific type of cat. On the other hand, if we have icons for all the existing types of objects, then it might not be easy or worth it for some users, especially Browsers, to look at so many icons to find the required icon.

A good solution for solving this problem could be what one of the participants of the second workshop mentioned about simple and advanced modes. He explained that maybe a user does not need to see all the icons or might only need to use either icons or text, but not both. So, the user does not need to see all the parts or information when searching. In this case the user can use the simple mode and spend less time on finding and adding different elements. If the user needs details or specific icons, then he can choose the advanced mode which contains all the details.

The participant’s idea matches with the aims of Iconic Search. First of all, Iconic Search does not aim to only focus on a few subjects or objects in available categories. The users might not see a certain icon in simple mode, but they know that it exists and is available and accessible for them if they want. Second, it supports different types of users: Browser, Searcher and Surfer, and matches their requirements. Therefore, a Browser does not need to see a lot of unnecessary information while Searchers and Surfers would have the details they need.

The question here is how the simple and advanced modes should look and how much information they should contain? At the beginning I started looking at letting users have two options to select from, simple and advanced mode, before they start their search. But in this situation the problem would remain, because now the question is which icons are in the simple mode and which ones are not? Additionally, a user might start in the simple mode and later notice that what he wants is not available in the list of icons. The reverse situation could also happen if the use starts his search from the beginning in advanced mode. Therefore, I tried to look at it in another way in which users have a smooth interface and can easily move between simple and advanced modes. I looked at simple and advanced modes as layers that are on top of each other instead of being separate from each other. This means, the default view is simple mode, in which the main icons that are representative of each object type are visible. For example, in the animal category, the user sees an icon of a cat, which means any kind of cat.
So, the user sees the simple mode as the top layer. The advance layer would be beneath the simple layer, which means the user could expand the main icon to see sub icons. For example, if a user wants to find a specific type of cat, he expands the cat icons and sees all types of cats.

15.1.2. Icon Color
In this section we will discuss icon color, first as something that is incorporated into the icon template, and second as a color that the user can select which affects the color of items in the search results.

15.1.2.1. Icon Color as a Template
As was mentioned previously, I had a discussion with the participants of the second workshop about how the icons could look. While some believed that the black and white illustrations as icons were good enough to find what they wanted, others preferred to have color images as icons. As it turns out, both groups were right. The first group believed that the icons helped them to define their requirements to search for images. But since they were not searching for icons themselves it was fine to have simple icons. They also believed that it is easier to visually scan through all the icons when they are black and white, because there is no color to distract them. On the other hand, the second group believed that it is easier to find the differences in the icons, like different breeds of the same animal, when the icons have color. They also believed that it is not realistic to have patterns in black and white icon as they were in the second workshop.

If we consider different types of users and levels of detail that users require, which is discussed in section 15.1.1, then we can almost match this with what users mentioned for color of icons. This means that maybe if the user is in simple (default) mode the user does not need to have color icons, and black and white icons would work well enough. However, the user might require color icons when he needs specific icons for a search and needs to see more details such as colors, patterns, etc. Then a black and white icon would not let the user see specific details and differences. For example, if a user is searching for cat images, the black and white icons might be good enough. But if he tries to find a specific type of cat amongst other types like Abyssinian, American Bobtail, Bengal, Bombay, Exotic, etc, then more details in the icons are required because here the difference is not only in shape but also in color and pattern. (Figure 34)
Future of Iconic Search

Figure 34. Left: Black and white icons for simple level. Right: Color icons for advanced level.

Having the icons for simple mode in black and white, and icons for advanced mode in color might seem like a conflict. One can argue that we could use color icons for both simple and advanced mode, as they can contain and transfer more information. However, I believe there is a value in what the users mentioned. Having this difference in simple and advanced mode lets users of future versions try both and discuss their ideas and suggest changes.

15.1.2.2. Picking Color for Items

The users should have the ability to select colors of the items that they are looking for. There should be a way that they can select colors for each item. This means that if for example they add four icons: a white cup, a black laptop, a brown table and a blue lamp, it should be possible to define colors for each object separately.

One way to address this idea is to have a color picker, which lets users add color after they add their icons. For example, by clicking on the color picker option in the search screen (where the icons are added), the color picker appears. The color picker could potentially not show a full spectrum, to avoid the problem that was mentioned in section 4.2.3, where users might not know which exact shade of blue to select to find the right image. The color picker could instead have one option for blue, which represents all shades of blue. The best functionality for the color picker could be to only show the colors that exist for each object type in the database. This means that if there is no blue cat in the images in the database, the color picker does not show blue for cats. For now, we will consider it to be a very simple color picker with several colors, where each color is a representative for all the different shades of that color (Figure 35).
15.1.3. Categories and Sub Categories

As was mentioned before, the icons would be in different categories such as animals, flowers, furniture, etc. Although this grouping would separate different subjects, it might not be enough when there are too many icons in each category. While some users might want to see all of the icons that exist in each category, others might want to limit the number of icons based on their requirements. Therefore, each category might need to have subcategories that let users limit the number of icons and save time when searching for icons. For example, in the category for animals, we could have pets and wild animals as subcategories. The subcategories could consider different features related to the parent category. For instance, in the category for animals we could also have mammals, birds, fish, reptiles, amphibians, etc as subcategories.

Sub categories could be organized in a way that matches simple and advanced mode. One way to do this would be to have the simple or most popular subcategories as the first rows displayed and more specific subcategories in later rows. For instance, in the previously mentioned example for animals we could have fish, birds, pets and wild animals on the first rows and others like mammals and reptiles at the end.

15.1.4. Editing the Steps

While users define their requirements, they might need to edit some parts or remove what they have added. This is especially important when they have a lot of details in their requirements, because if they cannot make edits, they have to start over from the beginning which is time consuming. To address this issue it should be possible to select each icon and edit or delete it. This means that the user can change the size, location and color of items by clicking on them and editing their properties, or the user can completely remove the icon by selecting the delete/ remove option.
15.1.5. Related Suggestions and Favorite Images
As previously mentioned in the details of section 11.2.3 users also wanted to have two additional options when searching. The first one was to see related subjects base on their search and/or previous searches. For example, if they search for the Eiffel Tower, they can see suggestions for other landmarks made out of metal or made in the 18th century. The users wanted to have the suggestions in a combination of visual and textual form, the same way that icons and their descriptions are in the tabs.

The second option that users wanted to have was keeping favorite images on a page, so they could have them in one place and compare them if required. It could be possible for users to add an image to their favorite list when they see thumbnails of images or when they see images at real size. It should preferably also let users save notes for with their favorite images or locate them in different categories if they want (Figure 36).

![Image of favorite images](image)

Figure 36. Users can save and categorize their favorite images.

15.1.6. User Groups and Related Categories
Iconic search can be useful for users who are looking for more detailed and specific images. It can be useful especially for graphic, industrial and web designers, architects, photographers, artists and users in similar fields that work with images a lot. Iconic Search can also be used for shopping centers, for example for a pet shop which contains different types of pets, or for shopping centers that sell different furniture. In addition, Iconic Search can especially be useful on mobile phones, when users have small screens and also small and touch keyboards. (See Appendix B: Other future possibilities of Iconic Search).

However Iconic Search cannot be used for all different users from different fields. For instance, it might be rarely used by engineers, doctors, researchers and so on. This is because first, the users from these
fields do not use images so often and second, it is not possible to have appropriate and detailed icons for what they require such as molecules, diseases, codes, etc.

Different users of first and second workshops also suggested other user groups for Iconic Search, which ranged from all users to children, the elderly, and so on. As certain user group has not tested in this thesis, I would like to consider it as an iterative process, which starts with a domain. If the domain fits the users’ requirements but they still need more, the users can expand it to reveal further details, and so on. As an instance, the starting point can be people that work with images a lot, such as designers and photographers. The categories then should match the user group. For example, designers and photographers might need animals, flowers, furniture, and so on.

The next iteration would be based on users and the images they use and upload. If users do not use initial categories, then it means the selected categories and/or user groups were incorrect. If users only use existing categories then the selected groups are correct and we can add other categories as a test. If the users add images that do not fit into the existing categories, then new categories should be added. To determine more details about the categories and user groups would require more time and user testing, and so is out of scope and time for this thesis.

15.1.7. Adding New Icons

As mentioned previously, Iconic Search aims to let users upload their own images and tag the items and icons that it contains. To achieve this goal, users should have the possibility to add icons. This is because it is probable that the icons that they require do not exist in the database. The question here is how users can find appropriate icons to add? And also how it is possible to have same level of uniformity in the icons that different users will add?

One possible solution is to use Edge Detection algorithm (Peli and Malah, 1982) (Barskar and Firdose Ahmed, 2011) to make the icons. This means that users upload the images of the items that they need as icon, and the system makes an icon from that. For example, user adds an image of a “hat” to add an icon for that. Then Iconic Search uses Edge Detection algorithm to create an icon of the image, which is a black and white sketchy picture. Here, same as the uploaded images, the icons should be revised, the duplicate icons should be removed, and the insufficient icons should be edited. These controls can be done by a team from Iconic Search or by different users.

15.1.8. Overall Layout and Functionality

Testing the second prototype showed some of the problems in interacting with different GUI elements, layout, controls, etc. For example the location of the textbox seemed inappropriate and one user totally forgot it was there. Therefore, the layout could be more organized, more clear and easier to interact with. Therefore, one idea for the user interface could be to use layers of transparency. So the controls or manipulation tools could “disappear in use to enable the user to engage directly with the “contents”, the “purpose” of the interaction” (Löwgren, 2007). This means the layout could be changed from ready-to-hand to present-at-hand (Löwgren, 2007). Here I will describe how different elements in Iconic
Search could work and contain some levels of transparency. While the aspects mentioned in this section and other details about the functionality and appearance of Iconic Search need more work, discussions, workshops, user tests, etc, the figures shows a rough sketch of the overall appearance of the concept.

In the beginning when a user enters the page would see a textbox for search. The aim was to keep the same layout for search that users are familiar with. The other parts, such as categories, requested images, etc are located in different tabs. So the user could expand and use them if he required. (Figure 37)

![Figure 37. Layout of Iconic Search when users enter the page.](image)

The user could add the icon in two ways. First, find the icon from the categories and add it by dragging it or [double] clicking on it. Second, type the word of the item in the textbox. Then the icon with that name would appear and the user could add it to the search screen (Figure 38).

![Figure 38. As users start typing the icons with that name would appear. The users can add icons either from here or from categories at left.](image)
The search screen, where the user could add icons and set their details, would appear either if he clicked on the icon which is next to the textbox or by having the mouse over an icon (Figure 39).

![Figure 39. Top right: As users pick an icon the search screen appears. Bottom: As users write a word or add an icon the search result appear.](image)

The user would see the search results as they add an item or write a word. By adding/editing each element the search results would change spontaneously (Figure 39).

As mentioned before, users can upload their images and tag the items that it contains, to improve the database (Figure 40).
Figure 40. Users can upload an image and tag the item that it contains.

Users can also request images or respond to other users’ requests (Figure 41).
Figure 41. Users can request images or respond to other users’ requests.

The other requirements, details and information mentioned previously, such as priority for items, terms and conditions, image revision, and so on need more study and discussion and are out of the scope of this thesis.
16. Conclusion and Future Steps

In this thesis I tried to find a future solution for Image Retrievals which changes them from their current state to a preferred state. By preferred state I mean an Image Retrieval that lets users describe their requirements in a simple and quick process, and also gets an appropriate result that matches with their requirements.

For this goal I used two methodologies, Research through Design and User Centered Design. These methodologies complemented each other, because the first one let me think broadly and consider different possibilities while the second one let me involve users as co-designers and allowed me to know more about users’ requirements.

I started with a literature review to explore the implications and requirements of searching for images. Then I surveyed and tried different Image Retrievals to find their features, advantages, disadvantages, gaps, etc. Analyzing the gathered information led to a hypothesis about a possible IR. After that, users became involved in my process, which played a crucial role and provided lots of useful information that I could not have discovered by myself. The communication with users was not possible without having low-fidelity and high-fidelity prototypes as sketches that were used in workshops and let us frame the concept and change and improve different aspects of it.

The final result is Iconic Search which mainly focuses on users who work with images a lot and need to find specific images or more details. Iconic Search lets users utilize available icons to define their requirements visually. It also goes a step further and lets them describe the approximation of the images that they need by setting the size, position and color of the icons used. Iconic Search utilizes text to go beyond the limitations that using only icons can have. So, using text lets users define the abstractions that are not visible in the image itself. Users can use this system to find photos, sketches, clip-arts and icons that have the same composition or contain the same items.

In addition, Iconic Search involves people in the result of search. This means it lets people upload their images and tag the items/subjects that they contain. It also lets them help other users indirectly, by replying to their requests for a specific image with an image that matches.

Iconic Search has some problems though; it is not as broad as other IR’s and cannot contain every images, such as celebrities, maps, etc. Besides, Iconic Search cannot be used for all different users from different fields. While iconic search can be very useful for users who work with images a lot, such as designers, architects, photographers and artists, it can be rarely used by engineers, doctors, researchers and so on. In addition, since the users need to combine text and icons, it takes more time compared to some of the other IR’s, such as search by keyword which only utilizes text. However the main focus of Iconic Search is not to cover every image type or category, but instead to be more functional in the fields that it can support. Therefore, it is not a replacement for other Image search engines but instead aims to provide an additional option for users.
In this thesis there were many unanswered questions about, terms and conditions, image verification, and so on. In addition, as mentioned there were many issues that needed more research, work, test, etc. For example, layout, functionality of different parts, role of people, and so on. The next step is to find answers to these questions and issues. While I have discussed different future possibilities for Iconic Search, finding these answers might lead to other new aspects and possibilities.
17. References


Bhattacharya, P. and Rahman, M.M., Image retrieval with automatic query expansion based on local analysis in a semantical concept feature space.


**Figures:**

Figure 9. Used exactly as the figure in: Springmann, M., Al Kabary, I. and Schuldt, H., 2010. Experiences with QbS: Challenges and Evaluation of Known Image Search based on User-Drawn Sketches.


Other figures created by me or were from my or participants experiences.
18. Appendices

18.1. Appendix A: Inspiration
That was a period when profile pictures in the Facebook (2012) were replacing one by one with mangatar face of the Facebook user. To me, who was never satisfied with different applications or websites that aimed to convert photos to mangatars or avatars, it was really interesting to find what is the website, software, etc that is doing it so good. By addition of each mangatar, I could easily say who the person is without checking the name. When I found the website (Face Your Manga, 2011), I totally surprised. There was no conversion at all, instead, users were supposed to make the mangatar face themselves by picking different parts like eyes, nose, eyebrows, hair, background, accessories, dress, etc from available options of each kind. The application also contained a color picker and some limited movement options for some parts, like the distance between eyes or between lip and nose. (Figure 42 and Figure 43)

![Figure 42. The "Face Your Manga" website.](image)

![Figure 43. Created mangatars with "Face Your Manga" website.](image)
Probably if I had not seen the results I would not try that, because it looked quite smaller than what I had tried many years before for creating avatars in yahoo messenger that also needs picking and combining different parts. I started picking and matching different parts and few minutes later my mangatar was ready. The process was simple and interesting. Not only I made a mangatar of myself, but also I made mangatar faces of my sibling and my close friend. I satisfied with all the results and they were surprised when they received their mangatar faces. Same as what I was thinking at the beginning, they thought I was converting their photos. While I could see that really rare to back to that website, I backed to that few months after, created mangatars, edited them in Photoshop and added full body to them, and used the completed mangatars in a short clip.

Although creating a mangatar face might be used rarely for many people and also it has a different concept from what I was facing, it had a major feature and advantage which was exactly what was needed in my case. The mangatar website let users describe the appearance of themselves or others. In other words, it let users define their imaginations and thoughts visually. While I was searching for the perfume, which I knew the appearance but not the name or brand, I wished same thing existed which could let me define the shape of perfume. I wished it was possible to pick the body and lid of perfume from some templates.

Although I believed it is not possible to use small parts to make a complete shape, the mangatar application and the way it let me define my imagination, remained as a good example of showing imaginations. These thoughts and other researches later led me to more ideas about visualizing imaginations and communicating with devices visually. The idea then changed to have a type instead of a part/shape and combine different types, items or concepts to visualize the request, which described in section 7.
18.2. Appendix B: Other future possibilities of Iconic Search

18.2.1. Iconic Search on Mobile Phones
Nowadays, with increasingly growth of smart phones, there are more and more people that use internet on their cell-phones. The user’s interaction with computer or tablet differs with his interaction with cell-phones. Small screens and also small and touch keyboards are some differences that make previewing and typing information more difficult. Therefore, having available icons for searching images let users skip typing, and instead tap or drag their subjects. For example, they can have 4 taps instead of writing cat in bed (See user’s idea section 11.2.4). This can make user’s searches easier and faster.

While the main concept of Iconic Search is same here, it needs some changes that matches small screens, and also small and touch keywords. For example, it might be required to do not see the search screen (where the icons are added), until the user is done with adding the required icons. The appearance of tabs, categories, etc, might also need some changes.

18.2.2. Iconic Search for Shopping Purposes
It was interesting to hear a use case for Iconic Search for shopping centers from two different persons in different times. First, in an informal conversation, when I was in early steps of brainstorming and second, in the second workshop. They both mentioned that it could also be useful for shopping centers to check if they have what you want and where it is locates, “Maybe IKEA (2012) can use it”. The second person also saw it the other way around, that user adds an icon for an item and see which shopping centers have that item.

Although there are many differences when using Iconic Search as an IR compare to when using that as a tool for shopping centers, there is a major similarity in them. They use visual information to achieve visual information. Means, they use icons to get images, maps, locations, etc. So, whether Iconic Search works as a search engine or not, it might work for shopping centers or similar concepts. Iconic Search as a tool for shopping centers needs more changes compare to using that on mobile phones. Although there would be less icons, Iconic Search for shopping centers still needs categories and sub categories. It can still retrieve the image of main item, so it should be possible to define color of items, but it might not be needed to define size and position of items.

While there is no need for having the parts that users can upload images or help each other, it should retrieve a map of shopping center and show the location of items and preferably also a direction towards that.

18.2.3. Iconic Search for Personal Collections
Iconic Search can be used in other data domains mentioned in section 2.1, especially in finding images in personal collections. While the main focus in personal collection IR’s is on face recognition, it can be useful to have an extra option that let users find images with other items in an image, instead of faces. The details about this possibility are out of the scope of this thesis.
18.3. Appendix C : Indices and symbols

Definition of Index and Symbol:

- Index: This is a sign that refers to an object, not by a similarity, but by a direct connection between the object and the sign. An index is a signifier that has a physical or causal connection with the signified. For example, a smoke icon is an index for fire, while footprints in sands show the path that a person has travelled. The majority of traffic signs are indexes.

- Symbol: A symbol neither has a similarity with its object, nor a connection with it. Instead, its meaning is learnt base on social and cultural rules or based on the virtue of a law. In other words, a symbol is a signifier that does not have a logical meaning or relation with the signified, but instead the relation is learned. Language in general, words, mathematic symbols, numbers, codes, national flags, traffic light, etc are examples of symbols.