Improving the User Experience of Document Search: Case M-Files

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Search is a widely used tool. It is a standard element that can be found on web sites, online stores and in most software applications. Search needs to be easily accessible and answer to the users' needs for them to continue using it. This study focuses on document search and how to improve search for M-Files. M-Files is an intelligent information management system that stores data based on its content. The users can access the document based on what it is instead of where it is. This requires an effective search that the users are comfortable using. The purpose of this study is to see if setting UX goals to document search can improve its usability. The study also focuses on how to find the right UX goals and how to use them in the design. In addition, the use of artificial intelligence to enhance user experience was studied.

To be able to find the UX goals the users were consulted about their use of M-Files search. Based on the responses from the user questionnaire, three UX goals were formed: clarity, ease of use and controllability. Two prototypes were created based on the literature survey on designing search and the UX goals. The prototypes were identical, except that search filters were placed in different locations. Prototype A had filters on the right side of the layout, prototype B on the left. The prototypes were tested with eight users where they tested either the A or B prototype. The participants liked the improved design. They felt it was clearer, easier to use and it gave control for the users over the system. The added AI functionality was one element in improving usability. When the two designs were compared, prototype B with filters on the left side was a bit more efficient to use and it received higher scores from the participants.

The results from this study show that setting UX goals to a document search can improve its usability. It also became apparent throughout this study that the research on other forms of search than web is lacking and requires further studies.

Keywords: Search engines, Search user interface, Document search, User experience, User interface, Artificial intelligence

Table of Contents

1. Introduction 1
2. Search and usability 3
   2.1. Development of search interfaces 3
   2.2. UX best practices in search 6
      2.2.1. User experience and goals 6
      2.2.2. Level of expertise 8
      2.2.3. System 8
      2.2.4. The search box and its location 9
      2.2.5. Search engine results page 11
      2.2.6. Sorting, filters, and facets 13
      2.2.7. No results 19
   2.3. Artificial intelligence and search 19
3. Improving M-Files search experience 23
   3.1. M-Files search 24
   3.2. Research methodology 25
      3.2.1. Collecting data 26
      3.2.2. Usability testing 27
   3.3. Results 31
      3.3.1. User questionnaire 31
      3.3.2. User experience goals 33
      3.3.3. Prototype 37
      3.3.4. Prototype test results 43
4. Discussion 57
5. Conclusion 61
References 63
Appendices 70

1. Introduction

Search is an invaluable tool today. It can be found from most software applications. It is in mailboxes, computer databases, on eCommerce sites. Even Microsoft Word has its own search. Google has taught people to use search when looking for a certain item. However, in many databases, the search is slow and cumbersome, and requires many rules and filters to narrow the results down to what the user is looking for. When the search works well, it saves the user's time in locating the correct document, item or website fast and effortlessly.

The business idea of M-Files is to organize data in a new way, storing it based on the content. The user can access the documents based on what they are instead of where they are. To achieve this, the M-Files search plays an important part. The fastest way to access a document from M-Files is the search.

An effortless and intuitive search engine makes looking for documents and other resources more efficient and user friendly. The use of a search engine that learns from the user and suggests search words based on the user's previous searches and work could make the database a powerful tool, enabling the user to concentrate on their work instead of spending time trying to find the right document. Artificial intelligence would make it possible to fully achieve this.

Search has a long history; it has been developed since the time computers were invented. The first search interfaces were command-line based and required specific knowledge to use them. Creation of graphical user interfaces brought search to the regular users. The internet brought a new aspect to the search with more advanced search engines. As the use of internet grew and internet search engines evolved to be faster and smarter, people began using them for all their needs. Google search is so commonly used that googling has become a word that people use for any kind of search, not just Google [Wikipedia 2018]. Even some M-Files customers referred to M-Files search functionality as "the google search" indicating how common the term has become.

The design style for search is very simple. It hasn't changed much in the past years. Keeping search simple minimizes the user's cognitive load and allows the user to concentrate on the task at hand. As the search is widely used and an important part of any software, designing it with care is crucial for success. Despite

the search user interface seeming so simple, it has many aspects to consider to ensure the users get the most out of the search and from their experience with it. Search design should cover everything from the search box to the search results page, filters and everything in between. At the forefront of the design should be the user and their way of using the search.

Recent research over search engines and their use concentrates heavily on the web search engines. Research about other search engines is lacking, even though the use of search is becoming more prevalent. There is a clear research gap on how the use of internet search tools has affected people's attitudes towards using search in different types of software and how the technology of web search has influenced the development of search tools in database searches. This study will concentrate on the document search in M-Files and how to improve it according to the users' needs. The primary goal of this study is to see if setting user experience (UX) goals to search can help improve the perceived usability of the search. The secondary goal is to define the UX goals and how to consider these goals in the design. This study will also focus on the best practices on designing document search.

First, this thesis introduces the concept of search and usability. The second chapter covers the history of the search engine and its use. It focuses on user experience in search and introduces best practices for designing search user interfaces. Artificial intelligence is introduced as a part of a search tool. Chapter 3 focuses on the ways to improve M-Files search. It introduces M-Files and its current search user interface. The chapter also describes the process of finding user experience goals, designing a prototype of the new search user interface and testing it. The user questionnaire and the test results are analyzed and the UX goals and the prototype are presented. In Chapter 4 the results and this study are discussed, and future studies considered. Finally, Chapter 5 concludes the thesis with a short summary of the research carried out.

2. Search and usability

2.1. Development of search interfaces

Today nearly everyone knows what the word Google means. Even literate children with access to mobile devices or computers know and use Google. Google has had such an impact on the search engines that it nowadays provides the industry standard for all fields of search. However, search, or information retrieval, has not always been what it is today.

Information retrieval, according to Oxford reference's strict meaning, is "retrieving previously stored information" [Oxford Reference 2016a]. Even though web search engines have such a prominent position today, information retrieval consists of more than the internet searches. The development of information retrieval systems began back in 1945 when Vannevar Bush wrote an article to *The Atlantic Monthly*, where he introduced the idea of a nearly limitless data storage and a system to retrieve that data [Wall 2018].

After the computer was invented, the work to build a storage and retrieval system for the data began, and the first systems were built in the late 1940's [Sanderson and Croft 2012]. The systems were designed to hold a certain amount of data and to search the known documents in that system. The basis for this system came from the library indexing system [Wilson 2012, 17]. As the technologies improved, so did the information retrieval and storage systems, allowing for more storage space and faster and more accurate information recovery [Sanderson and Croft 2012].

The first search user interfaces took their model from an interaction between a librarian and a customer. They consisted of a dialog aiming to gather all of the relevant information about the user's needs to give back relevant results [Wilson 2012, 17]. These interfaces were based on working on the command-line, requiring knowledge of the operating commands [Hearst 2009]. As the computers developed further and they were able to process the search queries faster, the interfaces became more interactive. The dialogue-type information gathering changed, and it is now happening during and around the search [Wilson 2012, 17-18]. In the 1980s as the graphical user interfaces grew more popular and available to the public, form-type search interfaces emerged. Form-filling search

interfaces allowed the user to see all the data entry fields in one view and these later developed into the advanced search [Wilson 2012, 20-21].

The invention of the world wide web created a new aspect to the information retrieval systems. The amount of data grew rapidly, and it demanded a new kind of system and user interface to answer to the users' behavior online [Goker et al. 2009, 85-88; Wilson 2012, 25]. Users search websites with different goals in mind than when searching for a file in a database or a point of text in a document. In these cases their need is mostly qualified as informational; they have a need for information that they get through the search engine [Broder 2002]. The internet is used for both business and pleasure purposes, from searching and buying products to doing scientific research. The internet is searched with transactional goals aiming to perform a certain activity and navigational purposes trying to reach a certain web page in addition to informational goals [Giles and Lawrence 2000; Goker et al. 2009, 85-88]. These purposes have advanced the creation of different methods in ranking the search results and also how the data is searched for in the websites [Goker et al. 2009, 97]. Web search engines introduced an interface structure where the search box was at the top left with the search queries below it, and a scrollable list of search results on the right [Wilson 2012, 25-26]. This then evolved to the typical form of today's search engines with a keyword entry box and a separate list of search results. The results page has not changed a lot since 1997, keeping the interface simple, as can be seen in Figure 1 [Hearst 2009].

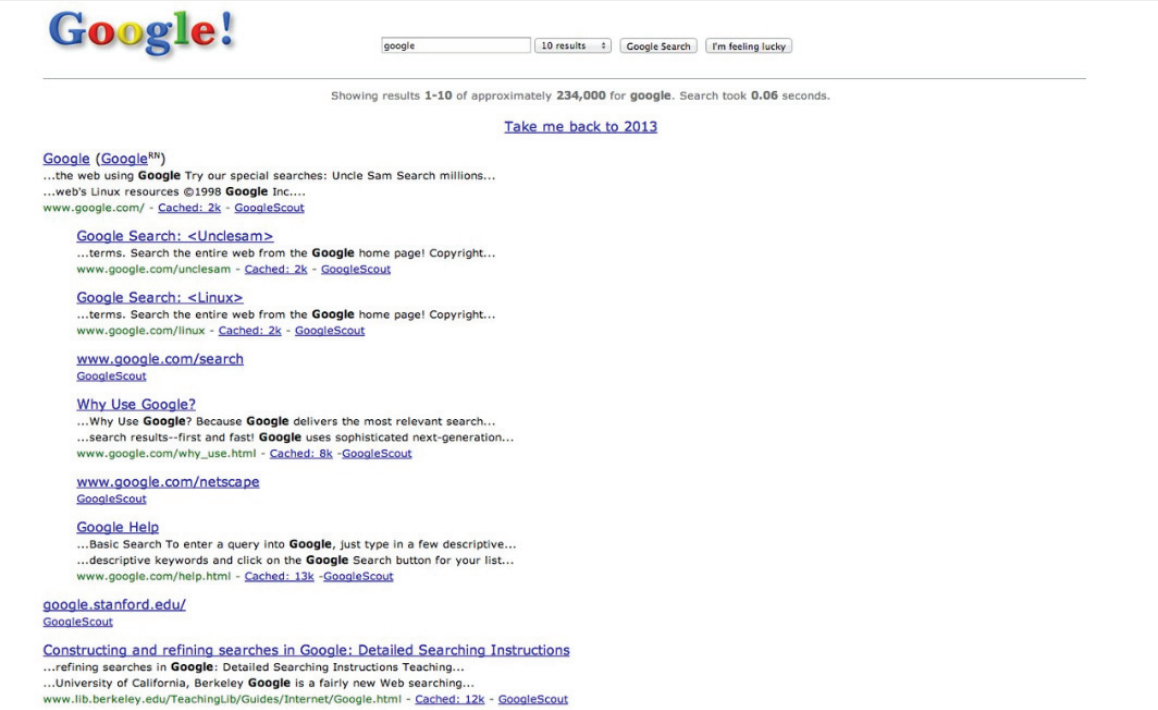


Figure 1. Google results page from 1998 looks familiar to the users of Google in 2018 [Shontell 2013. Retrieved September 23, 2018 from https://www.businessinsider.com/heres-what-google-looked-like-the-first-day-it-launched-in-1998-2013-9?r=US&IR=T&IR=T].

Until the 21st century, developers were mainly interested in how the search engines work and how they can optimize the search engines to answer to the user's queries [Levinson and Rose 2004]. The reasons behind the search were not evaluated. In 2004 Levinson and Rose [2004] raised the question of why users search instead of what they are searching for. They concluded that understanding the user goals can help improve the search engines and without that understanding, the search engines might concentrate on the wrong type of data [Levinson and Rose 2004]. Russell-Rose and Tate [2012, 1-2] also raise this question; they explore the why of the users' search to learn how users understand and navigate digital environments to improve the search experience for the users.

People have become more accepting of using the search engines as their primary means for finding information. Liaw and Huang [2003] concluded in their study that one of the main uses of internet is searching for information, and that people have more experience using the internet than they have using different types of software. The study was conducted in Taiwan with 120 students. It should be noted that the sample is relatively small and consists of a single location. Yet the findings seem to correlate with the amount of research done regarding the

internet search engines and the use of search engines. Google statistics show over 40 000 search queries worldwide per second [Internet live stats 2018].

2.2. UX best practices in search

On the surface, search seems very simple: a search box to enter the query, press enter or click on an icon and get a set of results in a list. The same method is used in nearly all computerized medias, the internet, different programs, and different software. Despite the apparent simplicity, there are a lot of things that need to be addressed when designing a good search experience that also provides accurate results.

A user interface's usability can be measured by how easy it is to use. Jakob Nielsen [2012] defines usability by five components that help measure the ease of use: learnability, efficiency, memorability, errors, and satisfaction. ISO 9241-210 standard measures usability by the effectiveness, efficiency, and satisfaction of achieving a goal with a system in a certain context [ISO 2010]. However, good usability isn't all that has to be considered. The user has a vital part in the design [Stewart 2015]. Design has to take into consideration the user, their needs, values, goals, expectations, and desires [Hassenzahl and Tractinsky 2006]. User experience, or UX, considers these aspects as well as the system being designed from the perspective of the business and the context where the system is being used [Hassenzahl and Tractinsky 2006]. User experience consists of the timeline in which the user is involved with the system. The experience begins when the user first learns about the system. It continues through different events involving the user and the system and the timeline ends when the user stops using the system [Roto et al. 2011]. In order to create products that raise experiences Hassenzahl [2011] instructs the designer to look at the why, what and how of the design, with the *why* clearing the needs and emotions of the function, the *what* directing the functionality that provides the experience and the *how* clarifying how the functionality is put to action.

2.2.1. User experience and goals

User experience design focuses on the experience of the product or system instead of the systems themselves. Therefore, the experience that the design is

aiming for should be at the forefront of the design process [Hassenzahl 2011]. To be able to do this, Hassenzahl [2011] instructs to design the experience before the product. When designing experiences, it is good to note that experiences are personal and they vary depending on the situation and context of use. Users' prior experiences, values, and cultural backgrounds all affect their view of the world, which affects their experiences [Roto et al. 2011]. Since experiences are personal and tied to the use context, a certain experience cannot be guaranteed. The designers should agree upon experience goals that they aim for with their design [Väätäjä et al. 2015]. These goals describe and define the experiences the designers aim for the users to have when using the system [Väätäjä et al. 2015]. The goals should give guidance over the whole design, they should be measurable, relate positive feelings and communicate the desired experiences to other people [Väätäjä et al. 2015]. Kaasinen et al. [2015] noticed in their study that defining user experience goals that are measurable and that give guidance for the design is hard. It can perhaps be concluded that the guidelines for a good UX goal are suggestive; however, it is not always required to strictly fill all requirements.

User experience goals can be identified most commonly by a user study [Väätäjä et al. 2015]. Other methods to use for finding inspiration in creating user experience goals are using visioning, co-designing and use of previous, published work [Varsaluoma et al. 2015]. Kaasinen et al. [2015] suggest five approaches for UX goal setting. These are brand image, scientific theory of human behavior, empathy towards users, possibilities and challenges of technology and vision for products' existence and new possibilities for it. The UX goals can at first be vaguer, bringing points for inspiration and guidance. Later they should be clarified to more specific goals that can be used for design implications. After the design is done, each design element should be explainable by the defined UX goals [Kaasinen et al. 2015].

The design process should start with the user. To be able to create a good user experience and improve the usability of the product, the designer has to understand the user [Russell-Rose and Tate 2012, 1-3]. Varsaluoma et al. [2015] noticed in their study of eliciting and communicating experience goals that experience goals are not always obtained from users. Instead the researcher, designer, specialist or developer influenced the goals. They warn that this can bring a risk of assumption and stereotypes to the design [Varsaluoma et al. 2015]. Kaasinen et al. [2015] also noticed the importance of users' needs, values, and preferences in their study. Understanding the user helped the designers formulate the UX

goals. The researchers used empathy that was gained by observations and interviews in order to understand the users and to step into their shoes [Kaasinen et al. 2015].

2.2.2. Level of expertise

Different users have different levels of experience for using computers and the product in question. This brings challenges to the user interface design [Shneiderman et al. 1997]. Research points to higher usability scores from the experienced users than from novice users, although Kortum and Johnson [2013] noticed in their study that this research may not be accurate in all use cases. Search is a tool that has users on many different levels of expertise and this should be taken into account in the search user interface design [Resnick and Bandos 2002]. An expert user searches for information differently than a novice user. Experts aim to get to their destination quickly by following links and getting deeper into their search while novices scout the information by going cursorily over several sites before dwelling deeper into one [Russell-Rose and Tate 2012, 4].

Russell-Rose and Tate [2012] suggest showing a list of related searches for novice users to help them form more successful search queries as well as showing breadcrumbs to avoid the user getting lost in the information trail. For expert users they suggest the possibility of using advanced search methods and filtering possibilities to help them get to their correct results faster [Russell-Rose and Tate 2012, 5-7]. They also suggest using the search interface's learnability to bring the novice and expert users closer to each other [Russell-Rose and Tate 2012, 11].

2.2.3. System

The purpose of a search user interface (SUI) is to help users with their need for information. The interface can help the user formulate a query, analyze the search results and keep track of the information seeking process [Hearst 2009]. Wilson [2012, 10] sees that there are six disciplines that affect the design of search user interface: user experience, human-computer interaction, information seeking, library and information science, information retrieval and graphic design. Information retrieval consists of how efficiently the algorithms find the relevant data. Information seeking looks at how and why people search for information

[Wilson 2012, 11-12]. Russell-Rose and Tate [2012, 71-73, 87-88] see search as a cognitive activity with several goals and activities and encourage designers to study the users' behavioral patterns and modes of interaction to apply them in their SUI design for a more effective search experience. Werner et al. [2016] also advise to understand users' search behavior in order to create successful search engines. They all apply different theories to their work, yet the user is in the center of their design, which points to the importance of understanding and involving the user in designing search user interfaces.

A typical search user interface structure is a text field for query formulation and results in a vertical list [Hearst 2009]. As previously stated, the search results listing hasn't changed much in the past years. SUI is kept simple for a reason; search is a task towards achieving a goal instead of being the goal [Hearst 2009]. Search also requires cognitive load and the user group is varied, so in order to attend to all users' needs, the SUI has to be clear and simplistic [Gwizdka 2009; Resnick and Bandos 2002; Hearst 2009].

2.2.4. The search box and its location

One of the crucial parts of the search UI is the search box. Today the search box is evident in nearly all search user interfaces and users scan for the box to type their query in [Nielsen 2001]. Both Nielsen [2001] and Wilson [2012, 29] support the use of search box instead of a link. The search box is flexible towards the users. Users can use their own language while formulating their queries and the query can be generic or specific depending on the users' needs and skillsets [Wilson 2012, 29]. The search box design should suggest the interaction of the box. The box should look like it is meant to accept text and it should have an accompanied action button close by [Russell-Rose and Tate 2012, 99]. It is also advised to show a "search" text in the box to indicate the functionality of the search box [Hearst 2009]. The action button used to have the text "search" in it although today in many places the magnifying glass icon has replaced the text. Nielsen & Norman group studied the use of the magnifying glass icon and came to the conclusion that when accompanied by a search box the users universally understand the magnifying glass icon meaning search [Sherwin 2014]. They also noticed that if the icon doesn't have the search box with it, users can't locate the search as easily as with the box, increasing the importance of the visibility of the search text box.

The search box's location is a key element in helping the users find it. Michael Bernard [2001] conducted a study of where users expect to find certain objects in web pages. He found that users looked for the search box from upper half of the page. A few looked for it from the top-right corner or from the bottom center. In 2002, Bernard published another survey of the search box location in eCommerce sites. These results indicated that the search box was looked for at the top-center and top-left of the page, as seen in Figure 2 [Bernard 2002]. Nielsen instructs to locate the search box at the top of the page [Nielsen 2001]. According to Nielsen & Norman group's research, people are used to having the search box at the top-right corner and that is where they search for it first, yet the box can also be at the top-left [Sherwin 2014; Nielsen 2001]. Bernard's study is partly in line with Nielsen. The search box is searched from the top of the page. However, most of Bernard's test subjects looked for the search in the top-middle or the top-left of the page. These finding would allow the designers to place the search to the top of the page with freedom to choose the best location there.

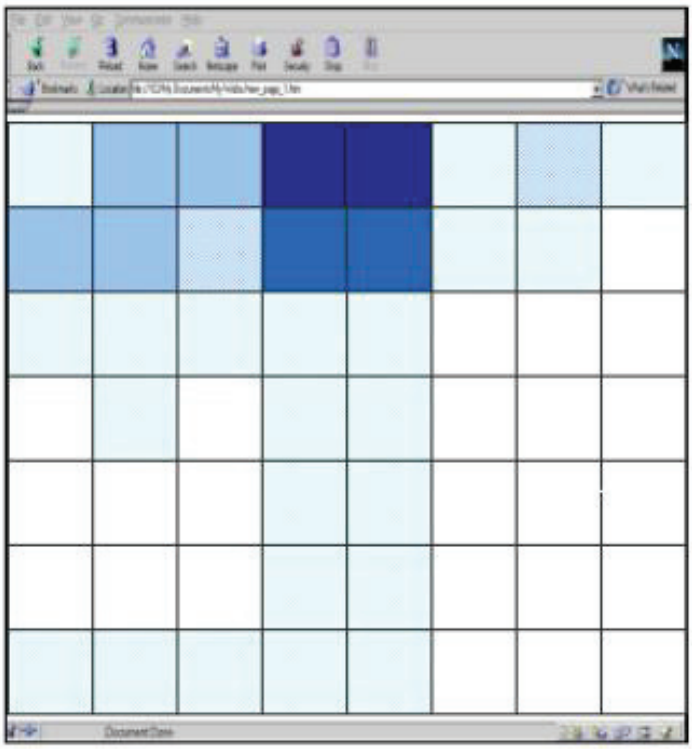


Figure 2. Bernard's [2002] study showed how users looked for the search from the top-center or top-left of the screen. Blue color indicates looks in an area. Image courtesy of Michael Bernard.

Scoped search means that the users search for information only in a selected category. The search can be built in a way that helps users narrow down the search scope before their search [Russell-Rose and Tate 2012, 102]. Norman and Nielsen

group [Sherwin 2015] warn designers that users tend to forget they have used a scoped search and they expect to search the whole site, not just a portion of it. To avoid this from happening the scope should be displayed prominently in the design and it should use the broadest category possible [Sherwin 2015]. Russell-Rose and Tate [2012, 103] express this point especially when the search returns zero results. They also suggest using a separate search box to search within the existing search results, narrowing down the search results this way [Russell-Rose and Tate 2012, 103-104]. In Figure 3 Newegg has a separate scoped search box placed above the product listing, away the from the global search box. If two sets of search boxes are used, these need to be clearly labeled to ensure the users know what they are doing [Russell-Rose and Tate 2012, 103-104].

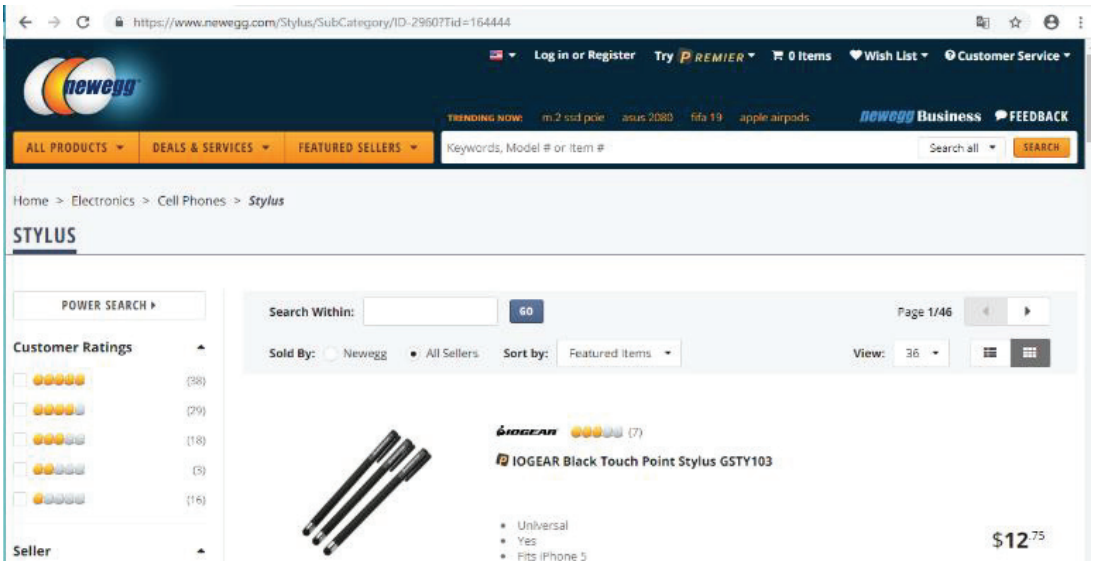


Figure 3. Newegg has a scoped search above the product listing and a separate search box on top of the page with the menu [Screenshot from Newegg 2018. Retrieved September 21, 2018 from https://www.newegg.com/Stylus/SubCategory/ID-2960?Tid=164444].

2.2.5. Search engine results page

Typically, the search results are shown after users press enter on the keyboard or click on the search button to start the search [Russell-Rose and Tate 2012, 123; Hearst 2009]. Search engine result page, or SERP, shows the results that match users' search query. The results are most often displayed in a vertical list below the search box [Hearst 2009]; however, depending on the content, the results can be also seen in a grid view [Russell-Rose and Tate 2012, 143]. The amount of information shown of the search items varies between different search interfaces. However, when considering what information to show, it is important to

understand that the given information guides the users to find the correct results more easily [Hearst 2009; Russell-Rose and Tate 2012, 129-132].

Russell-Rose and Tate [2012, 132] bring up the importance of context when considering what information to give in the search results. Photos of products are vital in eCommerce; however, when searching for a certain document, the document's content is important. Snippets or extractions in the search results that show the search query in the used context can be added to document search. These can help the users find what they are looking for faster [Russell-Rose and Tate 2012, 131-132; Hearst 2009]. As recognition is stronger for people than recall, Russell-Rose and Tate [2012, 132] point out that using thumbnails can help the users find a previously known item faster than a set of text. Wilson [2012, 53] agrees with this yet points out that the thumbnails only work when the user can recognize the page visually. When the search results consist of images, the thumbnails' meaning is stressed more [Wilson 2012, 53]. Yet the space where the search results are shown is limited, and the more information is shown per item, the less items can be presented. Russell-Rose and Tate [2012, 132-134] and Wilson [2012, 56-57] suggest using previews to allow for more search results while giving the user sufficient amount of information of the content of the search result item. Hearst [2009] raises the importance of highlighting the search terms in the search results to attract the users' attention to the searched term, helping the users evaluate how well the result item matched their search goal.

In addition to showing the search results in a way to help the users find the relevant information faster, the search engine result page should help the user to advance the search and if necessary, reformulate the search query. Russell-Rose and Tate [2012, 138-139] advise to keep the search box and the searched term visible at all times. This helps the user keep in mind what the search query was and to reformulate it if necessary. Research also indicates that showing the number of results found helps the user understand the size of information available and aids in narrowing down the search query [Wilson 2012, 68; Russell-Rose and Tate 2012, 139].

The order of showing the search results is also meaningful. The web search engines calculate the result relevance by a variety of means and search engines such as Google have succeeded in their matches so well that users today mainly concentrate on only the first items [Russell-Rose and Tate 2012, 139-140]. Wilson [2012, 51] and Hearst [2009] also point out that searchers rarely scroll or look past

the first page of results, so it is important to have the most relevant information first. If the user doesn't find what they are looking for within the first results, the users either give up on their search or they reformulate their query for better results [Hearst 2009]. Because of this, Russell-Rose and Tate [2012, 139] point out that the order of results has an impact on the whole search experience. Even though the systems calculate the relevance of the results, it isn't necessary to show the relevance scores [Hearst 2009]. Hearst [2009] explains that the users should have knowledge on how to understand the relevance score for the score to be meaningful. In addition, she claims that the context of the query term is more relevant to the user than the score and Wilson [2012, 57] agrees with Hearst on both accounts.

2.2.6. Sorting, filters, and facets

As discussed previously, there are different ways to show the search results. Different users in different situations have unique needs. Giving the user the ability to decide in what order they want to look at the results allows the users to feel in control of the search [Wilson 2012, 45].

Sort options can be placed in a dropdown list [Russell-Rose and Tate 2012, 152], seen in Figure 4, or in the column headers of tabular view [Wilson 2012, 45], as seen in Figure 5. If the sort order is in the column header, any column should be able to be used for sorting the results [Wilson 2012, 45]. Sorting by column headers has some issues, as Russell-Rose and Tate [2012, 152-153] point out: sorting is only possible by the visible columns, which can be limiting to the user. Also, the sorting direction, ascending or descending, is not always apparent and might not work in a way the user is accustomed to. Hearst [2009] sees sorting useful for items that have an easily understandable order, such as ordering lists by date or by price. Russell-Rose and Tate [2012,153] agree, yet also point out that sorting a list alphabetically can be useful when e.g. scanning a list for a particular name. Meaningfulness of the sorting value comes from the users' context.

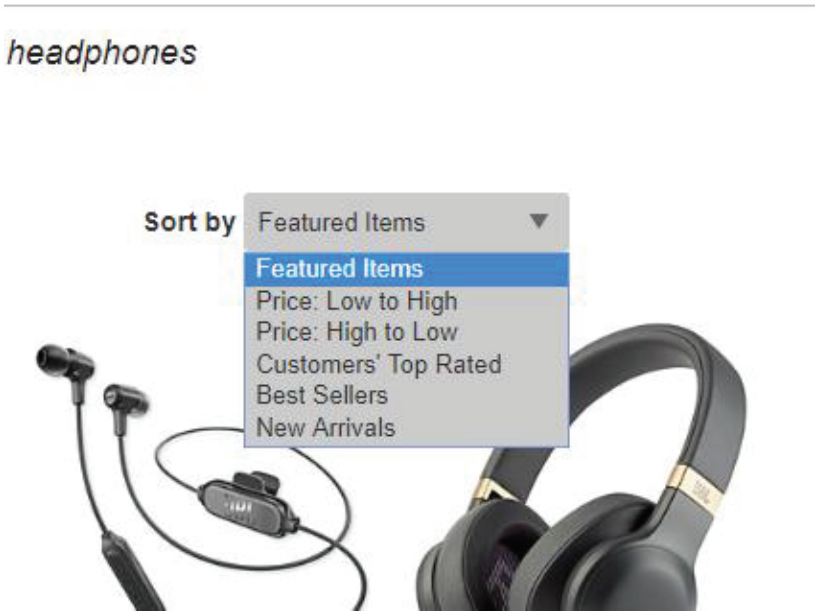


Figure 4. Sorting features of Macy's [Screenshot from Macy's 2018. Retrieved August 22, 2018 from https://www.macys.com/shop/featured/headphones. This image and the Macy's name are used with the permission of Macy's].

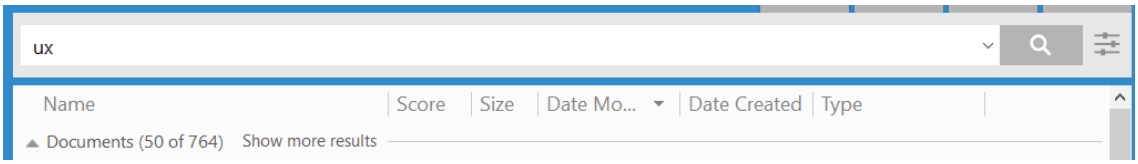


Figure 5. Sorting features of M-Files allow the user to sort by columns [Screenshot from M-Files 2018].

Another way to help users find what they are looking for is the use of filters. Filtering differs from sorting in a way that sorting organizes all of the results in a new way, while filtering removes items from the results list based on a single criterion [Russell-Rose and Tate 2012, 153]. Hearst [2009] suggests using filters for items that do not have a natural order. She also points out that using filters should not disturb previously set sort orders. Filters can be turned on or off [Hearst 2009]. Turning filters on removes items from the search results and turning filters off returns the removed items to the search results [Russell-Rose and Tate 2012, 153].

In basic filtering only one value from a pre-defined list of values can be used to narrow down search results. Facets are advanced filters that enable the user to select multiple values [Russell-Rose and Tate 2012, 168]. In addition, facets are more intelligent. The user can only select values included in the search results, which helps to avoid situations leading to no search results [Russell-Rose and

Tate 2012, 168]. Facets have become widely used in search user interfaces [Russell-Rose and Tate 2012, 153; Hearst 2009].

Nudelman [2011, 122] advises to keep the facets and filters visible and easily available to the user. Facets and filters can be placed vertically or horizontally on the page. With vertical layout they are placed on the side of the screen, as in Figure 6. Russell-Rose and Tate [2012, 169] argue in favor of placing vertical menus on the left since people are accustomed to looking for menus from there and the left side menu stays visible if the browser is smaller. The vertical layout also allows for more facets and keeps a visual continuum with the vertically listed search results [Russell-Rose and Tate 2012, 168]. Hubbard's [2017] comparison study of facet location between the left and right side of the page showed that users preferred the left side. Test subjects also seemed to find the left sided facets easier than ones on the right side. The study consisted only of one site; however, other studies seem to be in line with the results. Kalbach [2010b] argues that even though studies show that people prefer the left sided navigation, they adapt to the right side facets relatively quickly. From a usability perspective it is good to follow consistency and existing standards in user interfaces. Therefore forcing users to learn new placements for items creates unnecessary cognitive load for the users and is not recommended. Nielsen Norman Group also advices not to design against convention, they see that it enables users to make more mistakes [Harley 2017].

The facets and filters can alternatively be placed horizontally at the top of the page, as in Figure 7. This placement seems to be more problematic. Russell-Rose and Tate [2012, 169-170] point out that this style does not scale well and does not allow for many facets to be used. In fact, the number of displayed facets is dependent on the page width. The facets will also disappear if the user scrolls down on the page. Kalbach [2010b] points out that a horizontal facet at the top of the page is harder to miss than other facets; however, he too agrees on limitations of this placement. Kalbach [2010b] also notices that the horizontally placed facet groups require vertical stacks to list the facet values, which can interfere with viewing the results. Hearst [2006] points out that search usability principles require the user to see search results immediately after entering the query and the horizontal placement naturally lowers the result listing on the page. However, when there are no more than 4-5 facets, the horizontal placement should work [Kalbach 2010b].

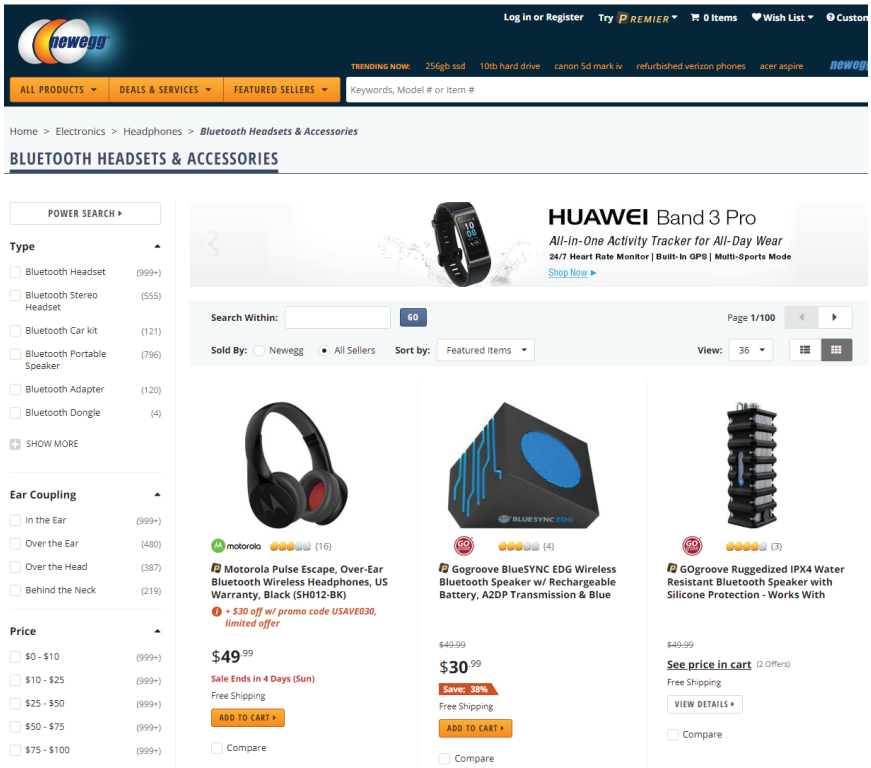


Figure 6. Newegg has facets placed on the left side of the page [Screenshot from Newegg 2018. Retrieved November 8, 2018 from https://www.newegg.com/Bluetooth-Headsets-Accessories/SubCategory/ID-565?Tid=167729].

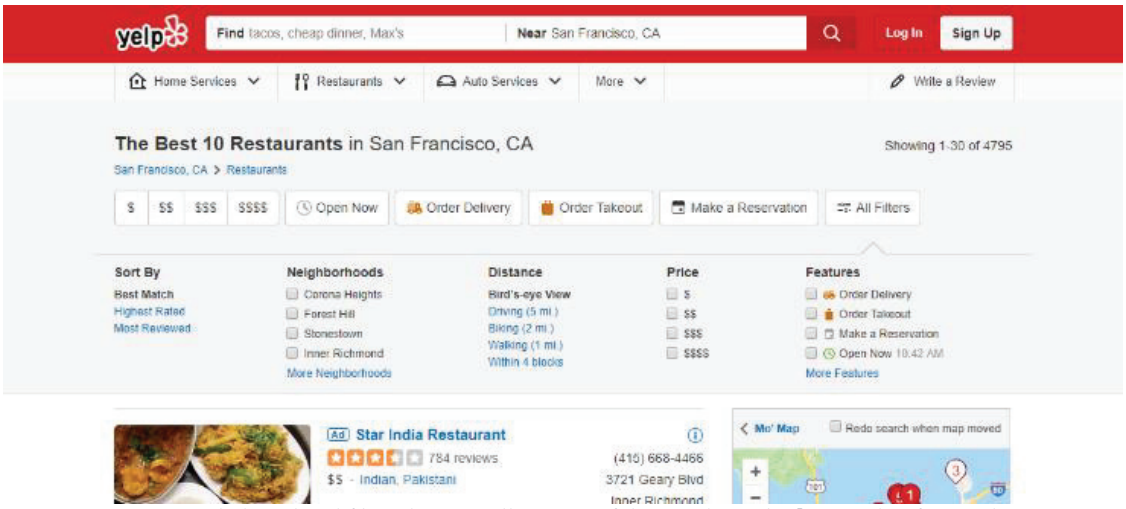


Figure 7. Yelp has placed filters horizontally on top of the search results [Screenshot from Yelp 2018. Retrieved September 21, 2018 from https://www.yelp.com/search?cflt=restaurants&find_loc=San+Francisco%2C+CA].

As the facet or filter categories have multiple selections and values, they can be displayed as closed or open by default. If the facets are displayed as closed, as seen in Figure 8, it saves screen space and allows for more facets to be shown before the page fold. This requires the user to click the selections open to see what the actual values are and to be able to use them [Russell-Rose and Tate 2012, 173-174]. Having facets open by default maximizes the information behind the

facets yet minimizes the number of visible facets. If all facets are open, the user might have to scroll to be able to see all the possible values to choose from [Hearst 2006]. Even if scrolling enables larger lists to be shown, few users want to go over long category lists and choices [Russell-Rose and Tate 2012, 190]. Also, the number of facets within a category might have to be minimized with an option to view more in order to keep the layout clear and to show more facet categories [Russell-Rose and Tate 2012, 174-175.] As both all closed, or all open selections have some issues, Russell-Rose and Tate [2012, 175] and Kalbach [2010a] feel that having the most important facets placed first and in an open state and the next facets closed is useful for the users and a good use of screen space. Also, Hearst [2006] advises to show the most relevant or the most often appearing facets first, especially if space for facets is limited.

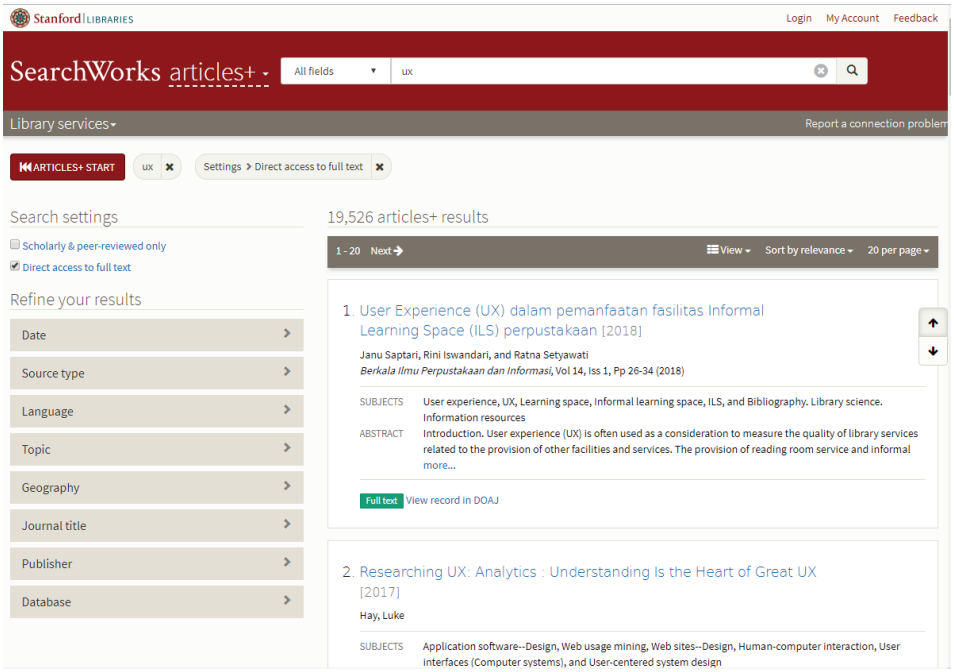


Figure 8. At Stanford libraries the facets are displayed as closed to show all of the facets at once [Screenshot from Stanford Libraries 2018. Retrieved September 21, 2018 from https://searchworks.stanford.edu/articles?q=ux&f%5Beds_search_limiters_facet%5D%5B%5D=Direct+access+to+full+text].

Facet values can be shown on the lists in different ways. They can be, for example, links, checkboxes, or sliders. Home Science Tools uses checkboxes and links, as can be seen in Figure 9. Hyperlinks give a clear and simple view of values for each facet [Russell-Rose and Tate 2012, 178]. Links can be used to select a single value for filtering or to move down a level in hierarchical facet structure [Nudelman 2011, 115]. Checkboxes allow the user to select several values from a selection. They also inform the user that certain items link together [Nudelman 2011, 116] and which items are selected [Russell-Rose and Tate 2012, 180]. Sliders

are useful when facet values represent quantitative data and they are used when the user wants to filter search items from a certain range. However, they can be clumsy to use, especially if aiming for a specific number [Russell-Rose and Tate 2012, 181-182]. Nielsen Norman Group advises to keep filter values understandable for all users and to avoid professional jargon in the labels [Moran 2018]. Also, the values in the facets should be of items that are available from the search results to avoid the "no results" -outcome [Nudelman 2011, 124].

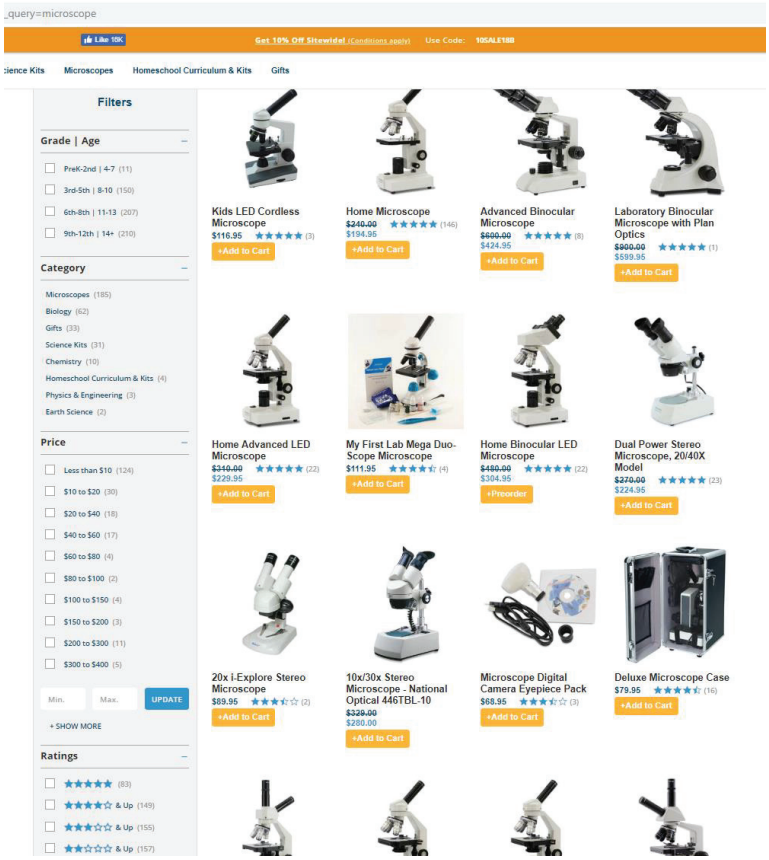


Figure 9. Home Science Tools has different types of facet values visible [Screenshot from homescience-tools.com. Retrieved November 8, 2018 from https://www.homesciencetools.com/search?search_query=microscope].

After the user has narrowed down the search results by filtering them, they need an easy way to know what filters are being used and how to deactivate the filters. Breadboxes show all the selected filter values in their own area. This keeps the active filters visible to the user [Russell-Rose and Tate 2012, 199-200]. The breadboxes can be displayed vertically or horizontally; however, Russell-Rose and Tate [2012, 200-201] feel that the vertical layout ties the selected facet values better together with the available values. More research on this would give insight into what method of displaying the active filters is most clear and preferred by the users. Baymard institute's research showed that users looked for applied

filters both in their original position and from a breadbox from where the user can easily see all selected filters [Holst 2015]. Keeping the active filters visible allows the user to quickly deselect the filters which are no longer relevant, keeping the user in control of the search [Holst 2015].

2.2.7. No results

Despite the efforts to help users formulate valid search queries, sometimes the queries do not receive any relevant results. It is important that the search user interface doesn't lead to a dead end, where the user doesn't know what happened [Wilson 2011, 42]. Even when the search provides no results, it is important to let the user know that there were no results found [Russell-Rose and Tate 2012, 148; Nudelman 2011, 5]. In addition to this, the user should be advised how to rectify the situation [Russell-Rose and Tate 2012, 148]. Nudelman [2011, 5, 9] advises to have only controls that help the user in the no results page situation and to remove unnecessary filter buttons from distracting the user. The search engine can suggest corrections to the search query or correct spelling errors automatically; however, the auto-corrections shouldn't be forced. The user has to have a choice to search for the erroneous query instead [Wilson 2012, 42]. The search engine can also show partial matches to the search query, yet the omitted keywords have to be shown to the user, so the user can see what words didn't work and get new ideas on how to reformulate the search query [Nudelman 2011, 12].

2.3. Artificial intelligence and search

Oxford Reference [2016b] defines artificial intelligence (AI) as a discipline studying computer programs capable of performing tasks requiring human-like intelligence. Artificial intelligence is part of computer science; it has several subfields, such as program verification and pattern recognition, and it also expands into other fields such as psychology and philosophy [Gustafson and Gustafson 2016]. Today AI can be found in many daily activities: speech recognition is on mobile phones, emails have spam filters that use machine learning to separate between desired email and spam, chatbots can be found on all over the internet instead of human customer service. Even robotic cars are being developed and tested. Use of AI in information retrieval is justified, since search interfaces that

use artificial intelligence, i.e. adapt to their users, provide better results than standard ranking systems [Mandl 2009, 151].

In information retrieval the users' query is indexed through several phases, the words are segmented and stemmed into their basic form, and extra words like prepositions are removed. The word stems are compared to document representation and the documents most matching the query are shown to the user as search results [Mandl 2009, 151-152]. In more advanced, intelligent systems, the contents of the documents are analyzed against the user's search query after which a similarity calculation is done [Mandl 2009, 152]. This system is based on natural language processing and it aims to provide more accurate search results [Goker et al. 2009, 216].

Research shows that when an information retrieval system uses profile information, such as information about user's needs and past searches, the accuracy of the search results improves [Snášel et al. 2010]. This is called information personalization [Hearst 2009]. Personalization can be user induced, where a user gives specific information by e.g. creating a profile [Hearst 2009]. Artificial intelligence collects the information automatically from the user's actions. The system can have a user profile system in itself that gathers relevant information about the user's behavior and then recommends content based on the user's individual actions or by the user's individual and other users' actions [Hearst 2009; Snášel et al. 2010]. The more data the system collects, the more accurate results the search will bring [Snášel et al. 2010]. Hearst [2009], however, warns that users might not like the system interfering with what the user wants, and she suggests careful use of personalization.

With machine learning, the computer optimizes its performance criterion by using the users' past behavior [Alpaydin and Bach 2014, 3]. The system adapts as it gets new information [Feldman 2012, 89]. Machine learning can, for example, use association rules to point out items a user might be interested in based on several users' behavior. It can classify users and predict their behavior with supervised learning [Alpaydin and Bach 2014, 4-5,]. The possibilities are numerous. However, the needed intelligence type depends on the program it is used for. Usually AI is not directly visible to the user. It is used to anticipate the users' needs to help the users find what they are looking for faster.

As the search engines have developed, they have integrated systems to help the users in their query formulations. In 2009 Hearst found that 10-15% of search queries had spelling errors that provide false or no results. To correct this, spelling suggestions and corrections were implemented [Hearst 2009]. Autocomplete improves spelling corrections by refining and expanding the search terms [Hearst 2009]. The autocomplete reads the characters written in the search box and aims to predict the query [Russell-Rose and Tate 2012, 109] helping the user avoid typing errors [Nudelman 2011, 28]. The predictions are placed below the search box [Hearst 2009] from where the user can select the predicted text or continue to write on the search box [Russell-Rose and Tate 2012, 109]. The benefits for autocomplete come from recognizing the wanted search term instead of having to recall it, lowering the user's cognitive load, and according to Russell-Rose and Tate [2012,109], it is most useful when the results are based on controlled vocabulary, such as directories.

Autosuggest takes autocomplete to the next level. Autosuggest doesn't limit itself to a set vocabulary, it searches for all related keywords and phrases, even if they do not match the exact search query [Russell-Rose and Tate 2012, 109]. Autosuggest takes the typed letters and words and understands the different ways a word can be written. It can relate to synonyms and understand acronyms in addition to understanding spelling errors. Autosuggest requires more intelligence from the search engine, as it is required to understand the meaning behind the words instead of matching the string of letters [Russell-Rose and Tate 2012, 110]. Mandl et al. [2015] found that mobile users saw autosuggest as helpful and inspiring. Their study concluded that autosuggest can help users in finding the right items and in avoiding spelling errors. Russell-Rose and Tate [2012, 110-111] were of the same opinion, although also warned that if the autosuggest provides many new suggestions it can increase the user's mental effort which the search is meant to minimize. Mandl et al. [2015] found that the autosuggest resulted in uncertainty and loss of time if the autosuggestion list was incomplete or the suggestions were irrelevant to the searched item. In a document database where the computer goes through a list of set values to answer to the user's query, to be able to work and provide value to the user, the suggestions should be realistic and found within the contents of the database [DeVries, personal interview, August 8, 2018].

Hearst [2009] evaluated White and Marchionini's study from 2007, where the users enjoyed the autosuggest, yet would have liked it better had it been faster. As

the technology has advanced since then and autosuggest can be found in most web search engines, Mandl et al. [2015] found that autosuggest was well accepted and used: only 10% of their test subjects functioned without hesitation when autosuggest was missing. Mandl et al. [2015] conducted their study on mobile eCommerce users, yet the results give indication of a wider acceptance and use of autosuggest, exactly as Hearst predicted in 2009.

As the fact-finding technology develops further, it can be included in the document storage. This technology would enable the users to directly type their question to the search box and the search engine looks over the storage for the answer. The search results page can display the answer, without the user having to open documents to find the required information [DeVries, personal interview, August 8, 2018].

3. Improving M-Files search experience

M-Files is a Finnish software company that specializes in enterprise information management solutions. M-Files was founded in 1987 and currently it employs over 500 people globally. Of these, there are 270 employees in Finland and 100 in North America. In addition to having company headquarters in Tampere, Finland, the company has offices in the United States of America, the United Kingdom, France, Germany, Sweden and Australia [M-Files 2018; Finder 2018].

The M-Files corporation designs and develops a software called M-Files, seen in Figure 10, as a solution to manage and store documents and other information in a secure way. M-Files bases its document management in metadata. This eliminates information silos that come from the traditional folder system and gives quick access to the content. The information in M-Files is saved in vaults and each vault has separate structure and features depending on its purpose. Users can have one vault or multiple vaults, depending on their needs. To be able to store the documents correctly, M-Files uses artificial intelligence to assist the users with the metadata creation and classifying information. M-Files can be connected to Microsoft Office applications and email, allowing for easy handling of the documents. M-Files can be used on desktop, web and mobile applications. [M-Files 2018]

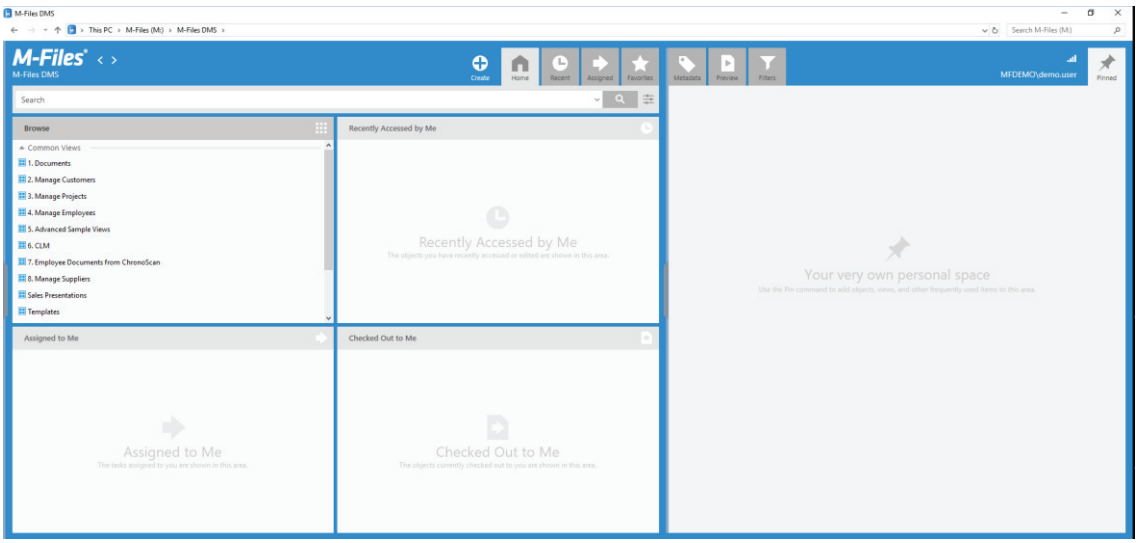


Figure 10. M-Files home screen [M-Files 2018].

3.1. M-Files search

The main idea of M-Files is that the user can find the data by what it is instead of where it is stored. This means that the user should be able to find a document with a few keywords, making the search a vitally important aspect of the program. M-Files corporation states that 100% of their users use search daily. Search is the fastest way to find information from the system.

M-Files search is a document search that is used specifically for finding documents based on their contents and metadata. Therefore, the use case is more limited than in more general search engines like Google. This enables adding more advanced filtering and other functionality tailored specifically for finding documents. Document search is also limited to a specific database which makes the scope of searching more limited than in web search engines.

Search has been improved over the years. The first search, which is still in use as a default search engine, is called dtSearch. DtSearch does not have facets. It is a simple system that has low requirements. DtSearch has search options that include searching with all words, any word and a Boolean search. The user can also select different properties of the document to be used as search criteria. Additional Conditions search, seen in Figure 11, is offered, where the user can select more precise conditions for their search. They can refine by status, property, file information and by permission. The Additional Conditions search is aimed for the expert users. The newer search system is called Micro Focus IDOL. Micro Focus IDOL is a stand-alone product that has been integrated with M-Files server. It supports faceted search, otherwise it has the same functionalities as dtSearch. Micro Focus IDOL can be found from the latest versions of M-Files. The users can also find documents by creating views that show documents with predefined criteria such as document type or document owner. "Common Views" that are created by default can be seen in Figure 11 on the left hand side.

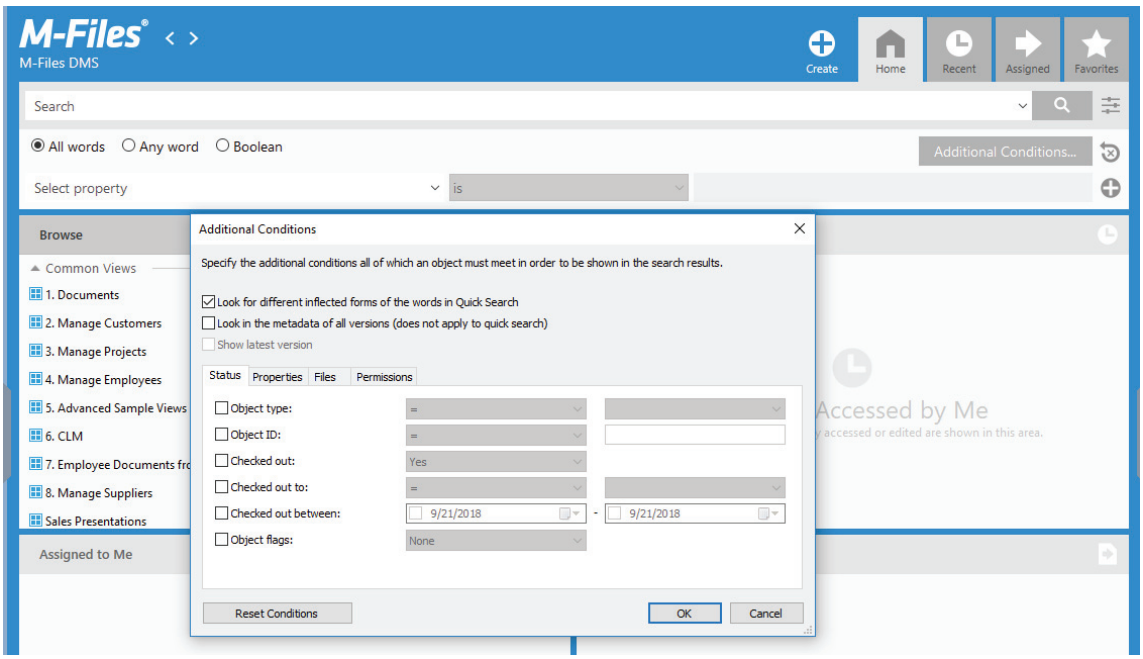


Figure 11. M-Files search options and additional conditions [M-Files 2018].

Both current search systems have some issues with usability. For example, the facets aren't used to their potential and the search is slow for today's standards. Also, the accuracy of search results could be improved. Users prefer using other methods, such as browsing or going over created "views", to using the search. M-Files aims to create a system that is more interactive and intelligent. Their aim is to increase the usability of the system by decreasing the user's cognitive load and increasing the search results accuracy. In the new system, the ideal is that the user can make mistakes, while the system minimizes the errors and provides accurate results.

3.2. Research methodology

This section introduces the methodology used in this study. First, the way the data was collected and analyzed is covered. Then the way the prototypes were done is introduced. The way prototype testing and the accompanied interview were designed and analyzed is also presented.

Based on the needs of M-Files and the best UX practices, the aim of this thesis is to see if setting UX goals and designing the search according to them can increase the usability of the M-Files search. The possibilities provided by AI to enhance the user experience will also be considered. This study combines previous research on search user interfaces for different websites and search engines presented in Chapter 2 and utilizes the previous research for a document search.

3.2.1. Collecting data

Like pointed out in Section 2.2., to achieve good user experience it is crucial to understand the needs of the users. For this reason, a qualitative research method was chosen. The users were sent an explorative questionnaire, in Appendix 1, with both multiple choice and open-ended questions regarding the use of M-Files search. Based on the questionnaire results, a prototype of M-Files search was created. The prototype was then tested with actual M-Files users. After the prototype tests, the users were interviewed in a semi-structured interview regarding the changes in the search and the users' opinions and feelings on it.

To be able to find the experience goals and pain points for the search, the above-mentioned questionnaire was sent to M-Files' current users. The questionnaire was done as an electronic questionnaire. The questionnaire link was sent to 10 different companies where their admin users were asked to forward the questionnaire to the end users. The number of people to whom the questionnaire link was sent is not known. 35 people answered the survey in three weeks' time.

The questionnaire consisted of 28 questions regarding the use of M-Files. The questions consisted of a few general background questions, asking for information on the participants' skill levels using M-Files and how long they have used it. Participants were also asked about what they use the search for and how they use it. From there the questionnaire went on to ask about the search results and how they are presented and whether participants use filters. Finally, the participants were asked to state their opinions on the things that work well in the current version and on the things that still need work regarding the search.

User experience goals were derived from the questionnaire results by looking for emotions that the system elicits in the users and for the pain points in the system. Based on these, three user experience goals were defined and used as goals in creating the prototype. These goals are clarity, ease of use and controllability.

3.2.2. Usability testing

A design prototype was done based on the interview results, user experience goals and the best practices found in academic research. The prototype was created by using Adobe XD, which allowed for some interaction in the prototype testing. However, the only interactions the prototype supported were those that were required to complete the test tasks. Prototypes created with Adobe XD do not allow typing with a keyboard. Typing was simulated so that text appeared when the participant clicked on the search box. The prototype is heavily based on M-Files' current look, as major changes were not wanted. The aim was to keep the same look and feel while bringing the desired UX goals to light. There was also some discussion on the filter location, as they are currently located on the right side of the layout. Because there was some controversy to the best practices and the organization's wishes, A/B testing on the filter locations was decided on. Prototype A had the filters on the right side of the layout, prototype B on the left side of the layout. Otherwise the prototypes were identical.

Prior to the prototype testing, three pilot tests were conducted with M-Files' employees. Based on the results from the pilot tests, the prototype test was evaluated and iterated. Main iterations were error fixings and some minor changes to the layout, such as minimizing a message about typing error and giving more room for the search results.

The prototype was tested with eight participants, six of whom also responded to the questionnaire. An email about the prototype and how the testing would go was sent to those who had stated their interest in testing the prototype. The email recipients were also asked if they had more volunteers for the tests in their corporations. Three new participants volunteered after hearing about the test from their colleague.

All selected prototype testers use M-Files at least weekly in their work. The participants varied from moderate users to administrator users. Half of the testers, four participants, had the latest version of M-Files in use, half had the older version that does not support filtering. The participants were from different types of companies, ranging from small to large, having different needs for the search. Document search is especially relevant for users that must search documents often from a large quantity of data. For this reason, participants that often use the

system were selected, since even minor changes to the search can bring significant improvements to their work.

The prototype testing was done in the participants' work premises by using a laptop computer. The tests were recorded using a screen capture program and a microphone. The participants had a mouse for pointing and navigating through links. The test was moderated by the researcher. An M-Files representative was also present during the tests as an observer. The participants were asked to think aloud during the test to allow for the moderator to know the exact pain points and the user's feelings throughout the test. Think aloud requires the participant to express aloud their thoughts and feelings as they are performing tasks.

Before each test the participants were told how the test would go and that the test was about the prototype, not the participants. All the participants were also told that they could quit the test whenever they wanted to. As the test was recorded, the participants were asked to sign a consent form to agree to the recording. The consent form can be found in Appendix 2.

The test tasks were designed to see how the users interacted with the system and what were their main methods of looking for information. The tasks were designed to see what the problem areas are when finding information and what areas work well with the users. The documents that the participants needed to find in the task were general project plans, presentations and similar files. They were not tailored for the test participants. The user interface had some new elements and changes to the existing elements, and their usability was investigated. The test assignments can be found in Table 1.

Table 1. Prototype test tasks.

1	Search for a project plan. You can click type the start of the word, but also check the suggestions the program gives if one of them works for you. You can only "type" the word "Project Plan" in this task.
2	Continue from the previous task. You know that the project plan you want is a pdf -file from 2018. It is an original file, but you do not remember the customer it is for. Something to do about quality consultation and the quality project.
3	You can look at the metadata and preview of the file you found. How would you clear the search criteria to get back to the original search results?
4	You have several results here. How would you sort them to find out which files are the newest?
5	Go back to the homepage
6	Do a new search. Search for a proposal, but do not use the autosuggestions, click type instead. Remember that you cannot use "Enter" to start the search. The only word that you can "type" in this task is "proposal"
7	You know the correct proposal is made by Rosalind Dunkley. You're not sure what file format it is nor when it was done.
8	You suddenly remember that the file was a sales training proposal for OMCC.
9	You know Rosalind has some assignments. Check what assignment Rosalind Dunkley has for the proposals.
10	Do you have the need to save searches as a view for yourself? If yes, do you have any idea how to do it from here?
11	Did you notice a search within field in the UI? What do you think will happen from it?

Task 1-3 introduces the participant to the filters and to the new information placed on the results lists. To find the correct document, the participant had to read the documents' names and snippets in the results listing. Task 4 tests how well the participant can sort the available information and task 5 the ways the participant go to the homepage. In task 6 the participant is shown results despite the typing error in the search box, testing how users react to the autocorrected results. In task 7 the participant has to use a filter that has several different values, testing how usable the large, alphabetized list is. Task 8 helps the user narrow down the results further and find the correct document. In task 9 the object type tabs are introduced, and the participant asked to use them. Task 10 investigates how well the users locate the new "Save current search as a view" button and how easily they know how to use it. Task 11 considers the intuitiveness of the scoped search.

After the test tasks the participants were interviewed with a semi-structured interview regarding their thoughts and feelings on the prototype. The interview questions can be found in Appendix 3. The interviews were conducted either in

English or in Finnish depending on the participant's preferences. The interviews lasted from 15 to 30 minutes depending on the interviewee. The interview questions included short background questions and general questions on how the participants felt about using the search and what were their initial thoughts on the search. The participants were asked to rate the prototype and their experience on a scale of 1-5 compared to the current system. In the scale, one was the lowest score, five was the highest. Participants were also asked about the good and bad qualities in the prototype and what were the most important functionalities that they would definitely like to have implemented in the system. Questions about personalization possibilities were also asked. The final interview was kept as an informal discussion between the interviewee and the moderator and observer. This allowed for the discussion to flow freely and the participant to express more opinions and feelings. The participants were invited to go over the prototype during the interview to refresh their memory.

The prototype testing was analyzed within a week of conducting the tests. The tasks were timed using the recording. The timer started once the participant had understood the task and it ended once the participant was, in their opinion, finished with the task. The ways the participant wanted to execute the task were noted as well as the problem areas. The times a moderator helped a participant in any form were also noted. Problems that arose were categorized and analyzed according to their severity. Task success was analyzed by whether the participant succeeded in the task or succeeded with help or clarification from the moderator. It was also noted if a participant could not complete the task or if the task was interrupted. The measurements used in this study to evaluate the performance and the UX goals were qualitative by nature. They focused on how the participants felt about using the system and what was their satisfaction, and the grade they gave to the system.

The interviews were transcribed. Additional notes were taken if the participant pointed to something on the screen while talking. The transcripts were analyzed in context of the user goals and the earlier user questionnaire. Both Shneiderman's [Wong 2018] and Nielsen's [Nielsen 1995] heuristics were used to evaluate the testing results.

3.3. Results

The results were collected and analyzed from data gained from the user questionnaire, prototype testing and interviews. This section covers the analysis for each method used in the study.

3.3.1. User questionnaire

The questionnaire provided insight into how the current users of M-Files use search and its functionality. This data was analyzed to understand how well it works and to identify potential improvement areas. The information gathered here was used together with the literature review in Chapter 2 to form the basis for designing the prototype used in the actual user testing. The survey was divided into six themes:

1. background questions, to evaluate the respondents' background and M-Files usage,
2. use of M-Files search, to see how the participants use the search and what are their most used search methods,
3. ways of searching to discover how much participants use the different methods that are offered,
4. search results, to discover how participants feel about the results they get and how accurate the results are,
5. filters, to see how the filters are being used and what the participants feel about them, and
6. general questions regarding M-Files search, to have the participants evaluate the good qualities and those that need improvements.

Most respondents had 1-3 years of experience (51,4%, 18 participants) of using the software. The respondent's skill levels of using computers was categorized into intermediate users and advanced users. Intermediate users, 37,1%, 13 participants, have mastered the basics and have developed additional skills, including the use of different software programs. Advanced users, 62,9%, 22 participants, are knowledgeable of hardware and software and able to solve problems and advise. 82,9%, 29 participants, felt confident in using M-Files and 71,4%, 25 participants, used M-Files several times a day.

Although the majority of the participants were comfortable using M-Files, many still felt that the software was difficult and complicated to use. The user interface received several comments on being old-fashioned, "*needing enhancements,*" and being "*very different from other programs, so it is difficult for people to adapt to it.*" A few respondents were worried how the end users managed some of the search properties, as it was difficult for the admins also: "*Additional fields and conditions are too complicated for normal users*" wrote one respondent. Another commented that "*narrowing the search results is challenging for regular users.*"

Search is used a lot even if participants see it as a slow and difficult way of finding files. One participant explained their search process as "*Try google search -too many results. Try to find correct view to find certain documentation, sometimes this works, sometimes not. Finally take advanced search and find by name, date and creator.*" This shows the complexity of the search. Another participant commented preferring views and recently used items over search, because: "*When using 'google search' my search words are often too common.*" The needs to use the search are wide: it was used in cases such as if the participants had to find documents based on content, if they were searching for files they use rarely, if they only know the subject they are looking for, and if the participants were looking for something specific.

Search results proved problematic. 19 participants (54,3%) commented that it takes a few minutes to find the correct item from the results, and 17 participants (48,6%) thought that the results were not clearly displayed in the search results. The search is not effective unless the search criteria can be found from the document's metadata, even if the actual document contains the defined criteria. The advanced users understand metadata, yet many users don't, which is a concern the respondents raised in their answers: "*user's lack of interest and knowledge about defining metadata to the objects is poor or mediocre at best,*" commented one user. Another problem was the order in which the results were shown, and the number of results shown. Users do not understand how the results are ordered and they feel overwhelmed with the high number of results. The results are displayed hierarchically based on the relationships between found documents. They see the hit highlighting as a good thing yet feel frustrated having to go over several hierarchies, or document relationships, to find the correct document from a document collection.

Facets, or filters, as the participants call them, were rarely used by 12 (34,3%) respondents. Only two participants use them always, six participants usually and seven participants had never used filters before. The participants pointed out problems restricting how many filters are available and the type of filters they use or would like to use. Many participants commented that the existing filters didn't answer to their needs. Participants also didn't see the filters working as well as they would have liked: "*it should work as well as in shopping online,*" commented one participant. The filters were also considered to be a bit hidden, which can affect how readily they are used.

M-Files received many compliments as well. Many participants complimented the system as a whole: "*I just love M-Files. Working is so much easier*" and: "*I'm a M-Files believer and I like it so much.*" One participant complimented the strong platform and the potential the system has. Even if the system has its problems, it is well liked and accepted. The search also received compliments, with participants applauding the search results highlighting the target words and the system searching from within documents as well. Also, being able to look at results from other vaults than the one where the user is currently located was complimented.

Search was considered the most important part of the software by 18 (51,4%) respondents. Eleven users considered it among the most useful features. According to the questionnaire every participant used the search functions at some point while using M-Files: 17 (48,6%) participants use search functions every time they use M-Files. Only four participants used them rarely. This concurs with the assessment of M-Files' personnel of the importance of the search to the program.

3.3.2. User experience goals

User experience goals were defined from the pain points and emotions that the M-Files search system elicits. The recurring problems and the feelings that accompany them gave indication to the issues that needed attention. From these, three experience goals rose that can help improve the system and create a better experience for the users. These were clarity, ease of use and controllability.

3.3.2.1 Clarity

Clarity aims to organize the content in a way that its meaning is clear to the users and it helps users to complete their desired actions. Many of the respondents felt that the M-Files search was complicated and demanding. By clarifying the user interface and the search functionalities, a sense of calmness and clarity can be brought to the users.

Respondents found the search overwhelming, which can lead to the user not using the system to its potential. One participant commented on the need to ask for help from colleagues if their searches do not seem to get results. Another participant commented on having to add more columns to ensure that they have found the right document from their search. Hammar [2015] demonstrated that the feeling of uncertainty and lack of control cause anxiety, which reduces the user's task performance. The issue of the system being too complicated rose regarding several different functions, most especially the search results and the advanced search functions. "*Advanced search functions is an unnecessary complication*" commented one participant with several others being in line with the statement. Another participant commented more generally that "*Finding documents is still too complicated.*" Overall, the user interface was seen to be difficult and outdated.

Offering the users feedback on their use can help them notice the actions and concentrate better on the available results. This can be done for example with hover effects in results listing, sorting and filtering. Offering information on the search criteria and number of items found helps the user understand how effective the search has been. Showing clearly which filters are in use gives the user feedback on contents of the search to refine it further or to correct existing criteria. Visual clues such as icons and clear work areas can reduce short term memory load and further clarify the use of the search. Being consistent in the design and using generally used standards can further clarify the system and the processes for the users. Clarifying the meaning of different items and their connections helps users understand the whole structure and functionality of the system.

3.3.2.2 Ease of use

Ease of use aims to make the user interface intuitive and natural for users, so that their cognitive load is minimized and the software can be used smoothly and efficiently.

A sense of frustration was common in using the search. Users did not not feel that they got the correct results from search itself. Therefore they tended to see different views and even browsing as a simpler and more accurate way of getting results. One user commented that the "*(search) functionality is not so helpful*" that they would want to do searches. Another commented that browsing is easier than "*trying to come up with suitable search criteria.*" Users want to use natural language in their searches and when the search system does not understand it, they get frustrated.

Especially the users that had used M-Files less than a year felt they only rarely got correct results and that they usually had to refine the search. However, even users with more experience in using M-Files felt the need to refine the search, use the advanced search features and try several times to get the correct results.

When the users got the results, the order in which they were shown was considered confusing; users did not understand the sort criteria being used. Also, narrowing down the results was seen as difficult, especially for the basic and intermediate users. "*I am worried about the end user*" commented one respondent about getting too many search results and trying to narrow them down. By simplifying the user interface and the terms in use the process can be made less demanding for the users.

To reduce the frustration that is closely related to getting the incorrect results, the result accuracy needs attention. At the moment, using more search words will widen the search further, instead of narrowing and focusing it on the content. Turning this around will enable the use of natural language in search and produce more accurate results. Users view natural language as the norm since it is used in Google and it is an easy way to use search. Having snippets in the search results will ensure the users that they have the correct results, as will showing previews of the results.

M-Files provides the possibility to create views containing documents with certain properties. As the views are used a lot as a way of saving and searching for information, simplifying the process of creating them will ease the users' frustration. Allowing for easier ways to create new views, such as creating a view from a successful search, will reduce the need for repeating complex searches.

3.3.2.3 Controllability

Controllability means that users have full control of the system and it behaves as expected in different situations.

M-Files users feel the search user interface is easily chaotic and not very logical; it is hard for them to understand. A participant commented that "*Search functionality which works very well, but it's not very logical,*" another commented that "*some people find it hard to use and understand principle.*" Users feel that they lose control of the search and end up having to ask for help. One participant commented that "*Document finding tools are quite poor or we don't have enough knowledge how to do it,*" another commented on how complicated finding documents is while another participant simply goes and asks for help from colleagues to find the correct documents.

The system should behave as the user expects it to, in order for the user to feel in control. Participants commented that filtering tools are not easy to find, they appear to be hidden. Placing the filters according to common practices would help users to notice and utilize them. Giving users multiple ways to easily refine the search criteria gives them control over the results. These can be filtering and an easy way of sorting through the results. Allowing users to search within the existing search results gives more ways to narrow them down. Users prefer shortcuts to many things and having easy access to correcting search criteria gives them the feeling of control. Allowing the users to personalize the software makes them feel more confident using it. Enabling users to save their searches as views, store personal filters, adjust font size and other appearance would make users more comfortable with the system. Allowing natural language in the search terms and enabling typing error corrections would also help the user feel that they have more control and freedom over their search.

3.3.3. Prototype

A prototype that shows the basic functionalities of the search was created. The prototype was done keeping in mind the M-Files design guidelines and the user questionnaire results as well as the set UX goals and best practices of designing search. M-Files is a widely used software and the sole product of the company that has been developing it for several years. To avoid confusion of existing users, the company did not want major changes to the basic layout and functionality of the software. On the other hand, there were some previously recognized feature requests that they wanted to include in the prototype, such as providing a clear view of available object types and being able to save search as a view.

The main change of the UI was the location of the search facets. In the current version the facets are located on the right-hand side panel of the two paneled UI, seen in Figure 12. Users felt that the facets were somewhat hidden, so the location was taken into consideration. The best practices of search design direct the filters to be placed vertically on the left side of the search results or horizontally on top of the search results as discussed in page 15. As the number of available facets can be more than five, the horizontal placement of facets was not seen as functional. In addition, the horizontal facets would have pushed the search results so far down that the users would have to scroll to see 10 results on the page. Vertical facets allow for more facet values to be shown without moving the search results too far down. Vertical facet listing also enables more values to be added without disrupting the design.

However, there was some discussion about the facet placement at M-Files and everyone was not convinced of placing the facets on the left-hand side of the results. For this reason, two prototypes were created: prototype A, where the facets were on the right-hand side of the search results, seen in Figure 13, and prototype B, where they were on the left-hand side, seen in Figure 14. Otherwise the prototypes were identical. The facet placement was then tested in A/B testing while testing the prototype.

Since the new placement of the facets makes them easily visible, a functionality to hide the facets from view was added. In prototype A hiding the filters allows for the Metadata card or the Preview to be fully visible in the right-hand side. In prototype B, hiding the filters will allow more room for the search results.

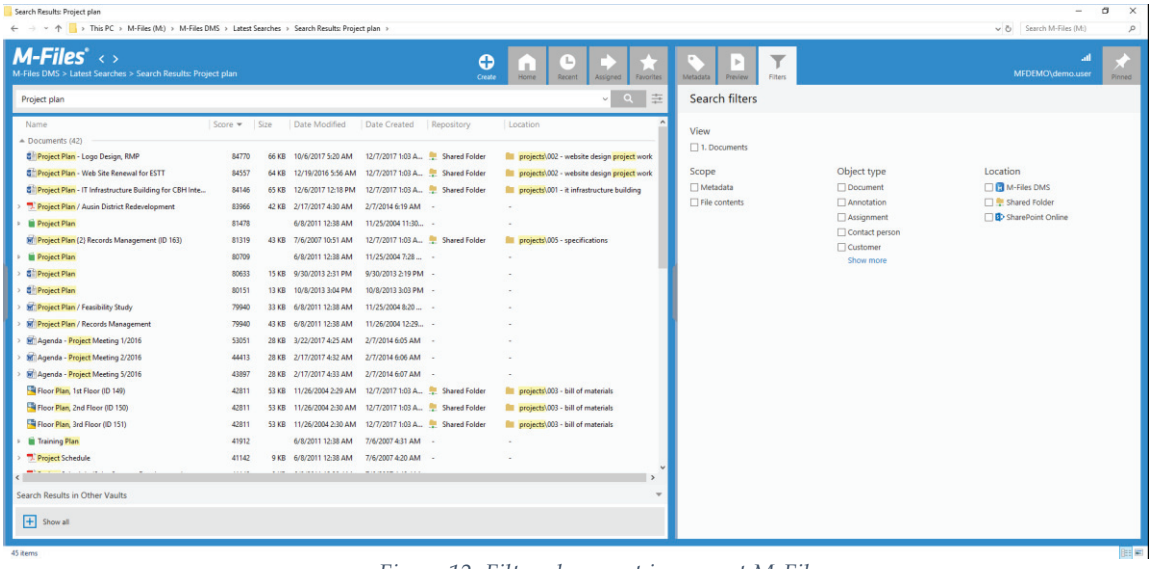


Figure 12. Filter placement in current M-Files.

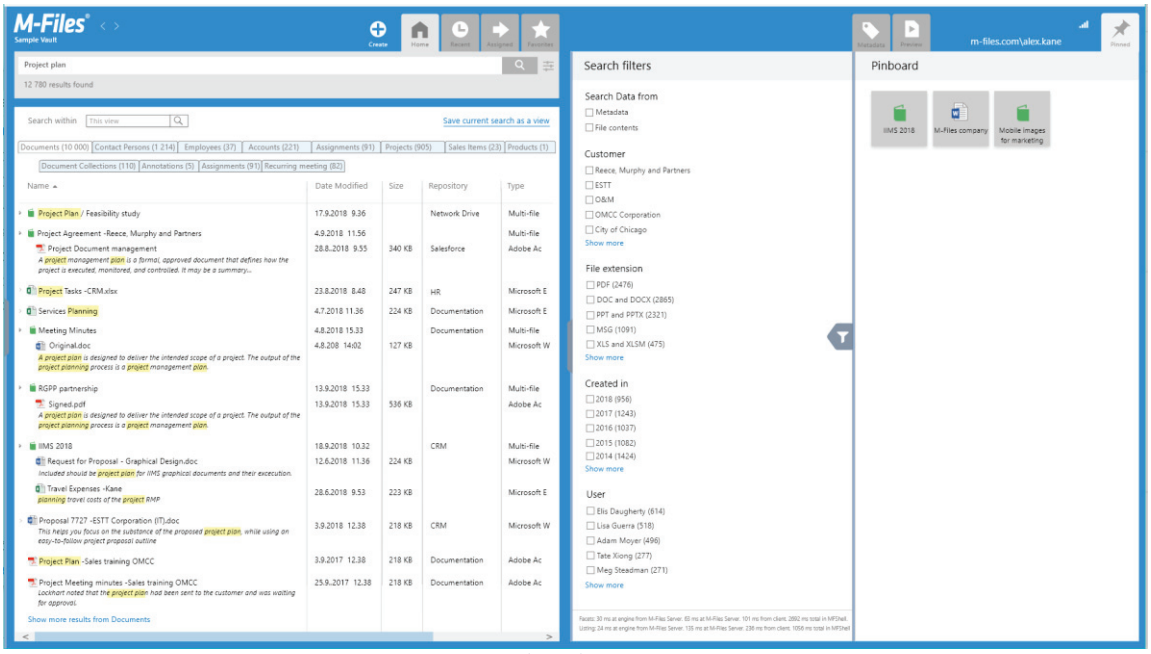


Figure 13. Filter placement in prototype A.

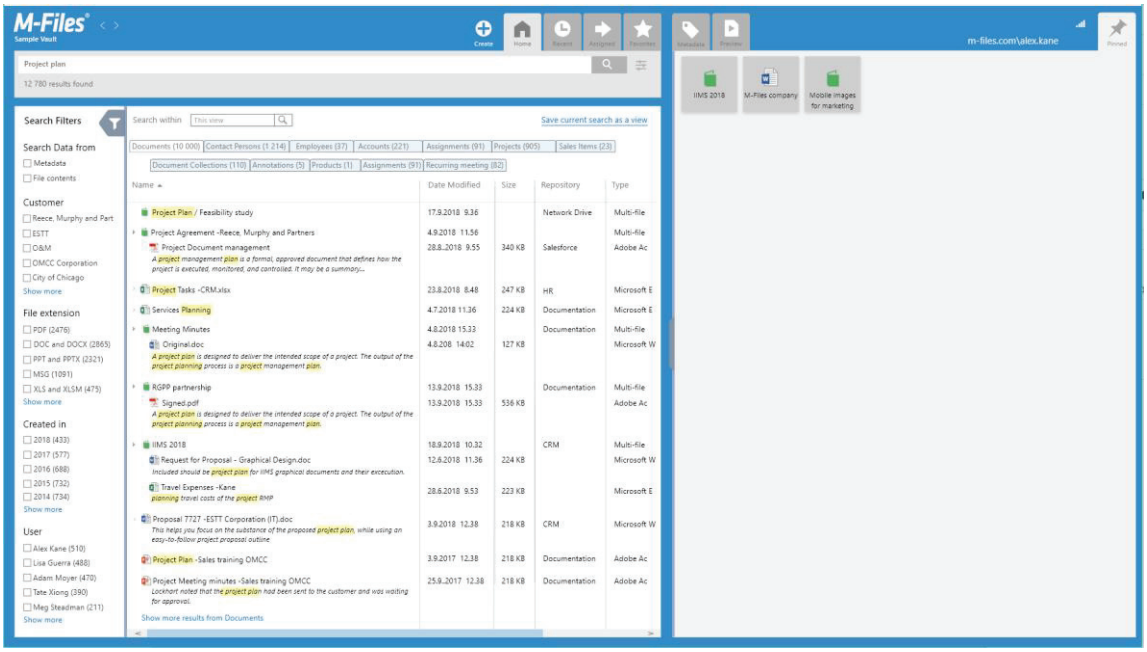


Figure 14. Filter placement in prototype B.

As the new search will be using AI, the prototype shows how the system gives search suggestions based on what the user has typed in the search box, seen in Figure 15. These autosuggestions change as the user types the word further. The suggestions also correct detected spelling errors, understanding "propsal" as "proposal". As the user questionnaire showed that the users like to see the search history as part of the suggestions, these were kept as part of the suggestions. To separate the search word suggestions and search history a line with a headline "search history" was inserted between the two. The spelling error corrections and the autosuggest allow the users to use natural language in their searches, making the search more natural and easier for them to use.

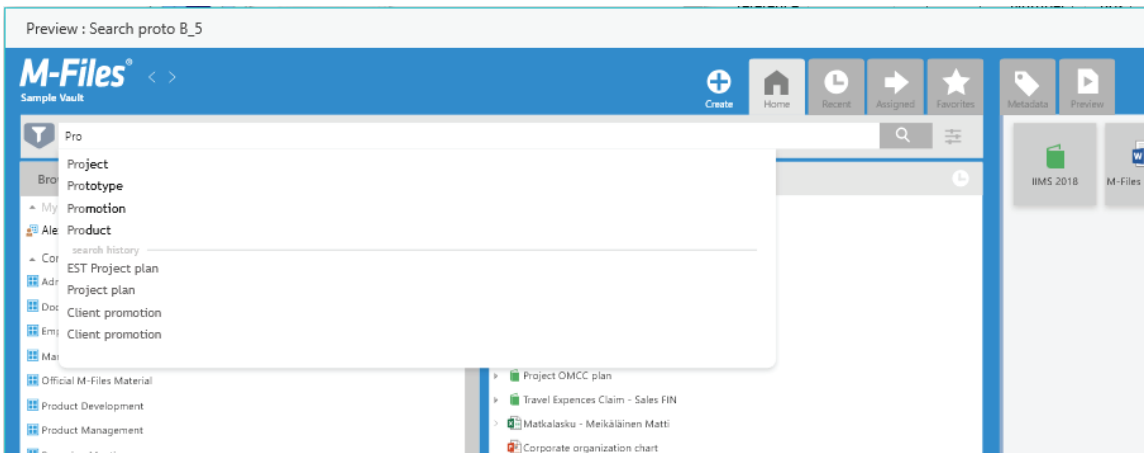


Figure 15. Search suggestions show below the search box.

Users gave feedback on how they have trouble finding the correct search results. For this reason, the search results listing was designed to give the users more clarity on the results and why they were shown, seen in Figure 16. If a search result hit belongs to a multi-file document, the main file is shown with the hit document below it. If the search result is not in the document's name, a snippet is shown indicating why the result was shown on the list. If the users like seeing the snippets, they could be added to all result hits.

The results listing shows only 10 results, as research indicates that users do not scroll or rarely look past the first items. Showing fewer results allows for showing more information about the results and keeping the results page uncluttered, making it easier to read. The limited amount of results also prevents the overwhelming feeling users can get with many results. Users can get more results by clicking a "Show more results" link at the bottom of the page. These results will be shown below the first shown results. To help the users understand what type of results are shown, the object type is indicated in the link. When the user is in the Documents tab, the link says, "Show more results from Documents".

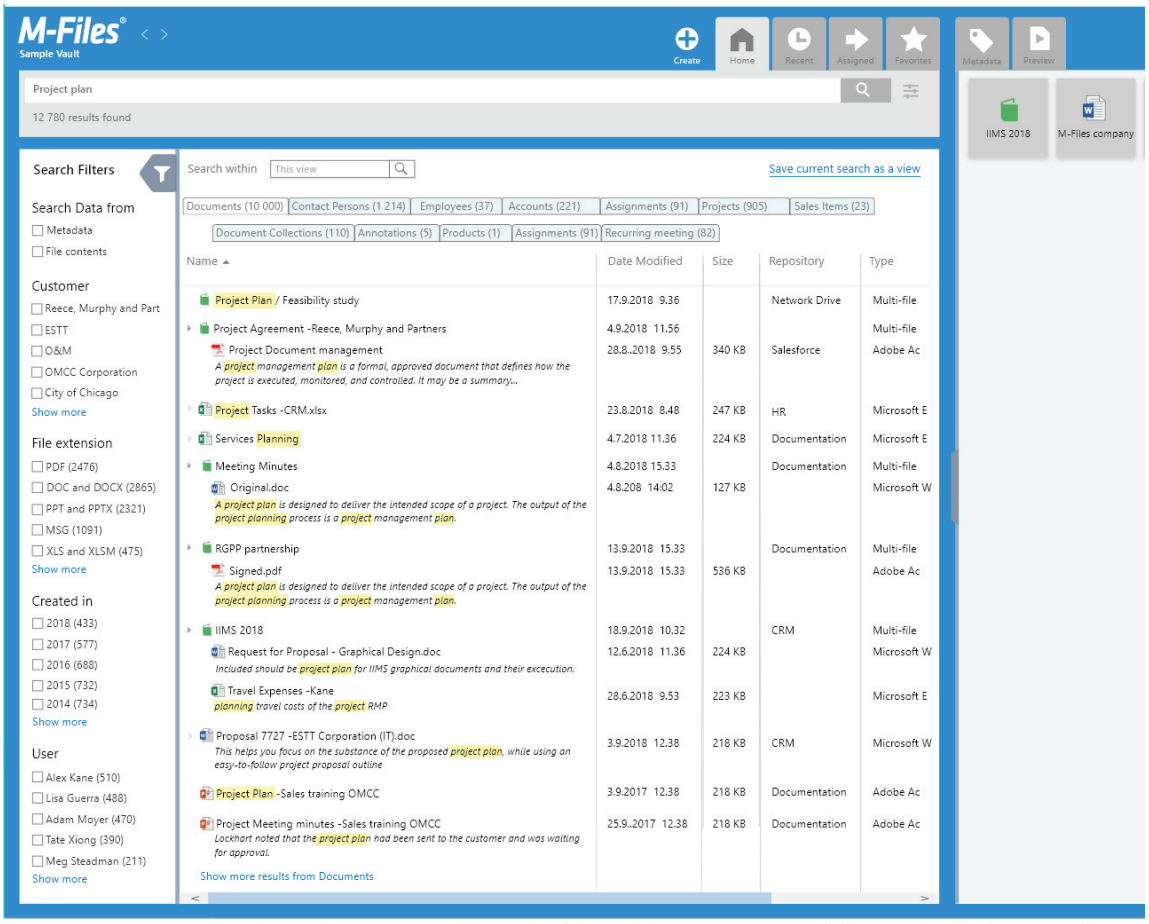


Figure 16. Search results are grouped by multi-files and have snippets available. Hit-highlighting enables users to find the correct results faster.

M-Files wanted the users to have a clear view of different object types available for searched items. The object types were placed in tabs on top of the search results. These tabs also show the amount of hits in each object type. The user can filter by object type by selecting the required tab. The "Documents" tab is selected by default, as this is the most common object type. Object types that have no search results are not shown.

The search results page also supports scoped search, which means searching from within received search results. The scoped search box is on top of the search results, separated from the regular search. A new addition to the search is allowing the user to create a view from the current search. This saves the user's search parameters into an easily accessible view that is placed on the homepage.

The facets are placed in new locations, as mentioned previously. In addition to this, the facet names have been changed to more natural language. E.g. "Scope" has been changed into "Search data within". The "object type" filter has been removed, since the object types are visible in the tabs above the search results. This has allowed for a new facet, "Customer", to be added. The user interface supports more facets to be listed below the page fold, with a scroll bar hinting to the users that there are more facets available below.

The facet value sub menus are partly open. The most relevant or most used values are visible by default as advised by Russell-Rose and Tate [2012, 174-175] and Kalbach [2010a]. More facet values are shown when the user clicks the "show more" link. Users have some facets that can have thousands of values. To allow for this and to maintain the clarity of the facet values, the additional values are shown in a separate pop up box that comes over the M-Files page, seen in Figure 17. When the facet value box is shown, the rest of the page is faded in the background to allow for more clearer view of the values. The default page shows the values that are most used by the user. The user can look at the facet values alphabetically, allowing for many values to be supported without cluttering the user's view while helping the user to find the correct value quickly. The facet pop-up box has a title showing the active facet, so the user knows which values are being selected. Figure 17 shows an example of the pop-up box. The user can select multiple values from the box. The results update when the user presses an "Apply filters" button or on the M-Files screen outside the box.

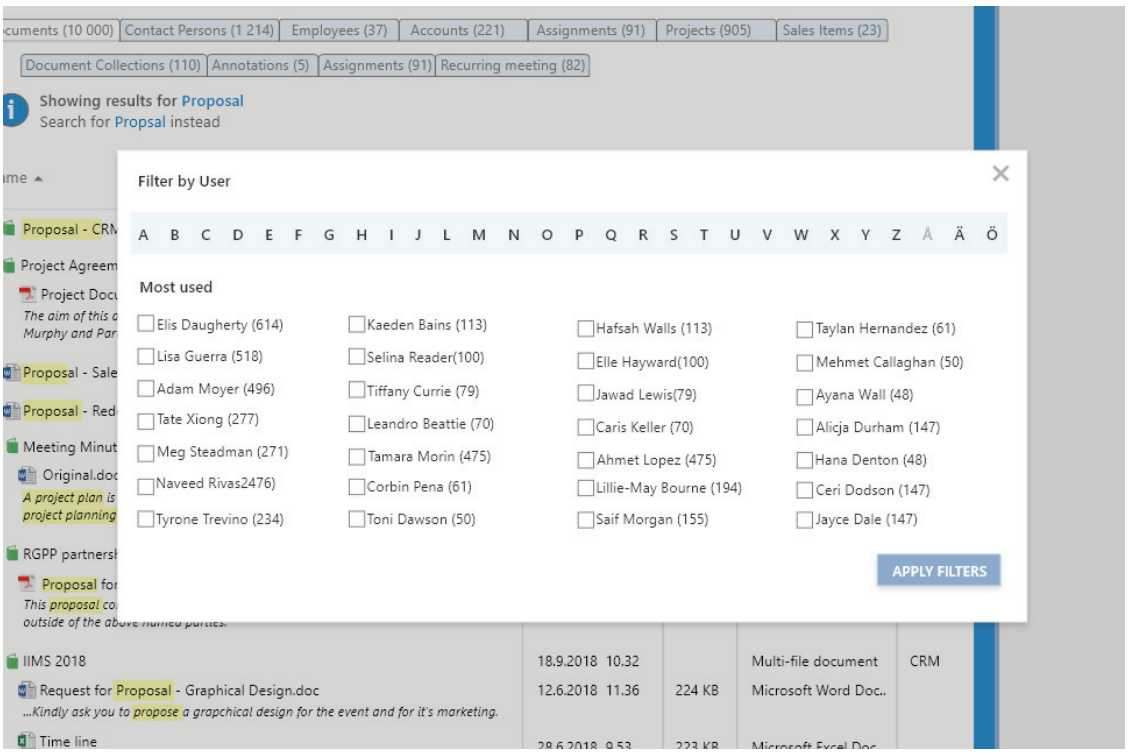


Figure 17. Filter values box pops up over the M-Files screen.

As the user selects facets, the results page is updated automatically as are the number of results found. The selected facet values are shown below the search box with links to clear said facets, as seen in Figure 18. Also, a "Clear all filters" button is added, from where the user can clear all facets with a single click.

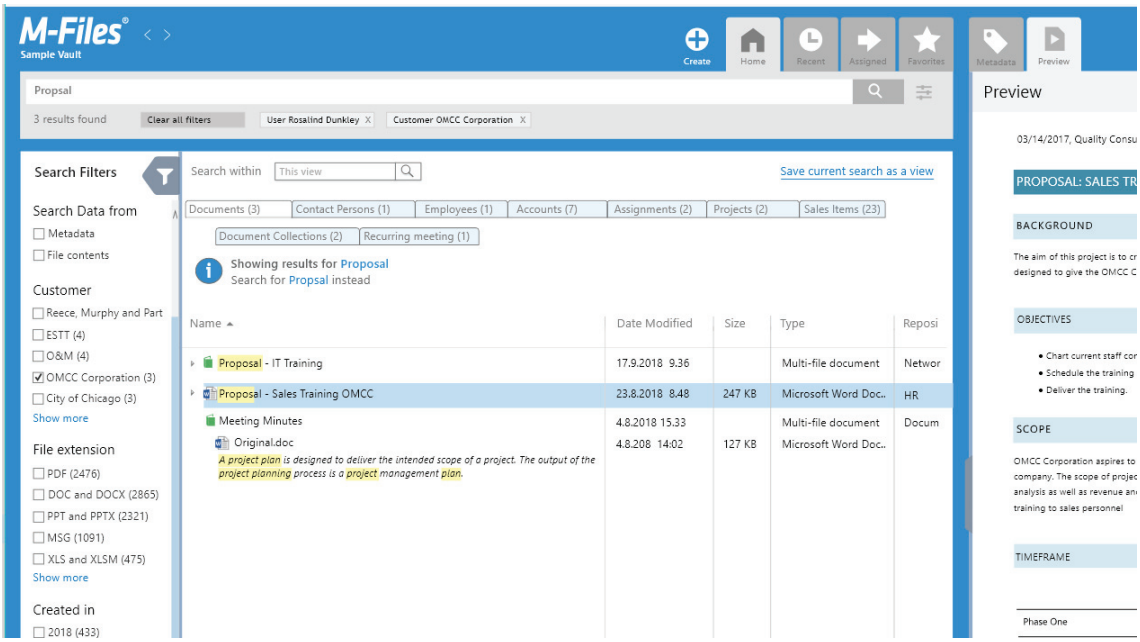


Figure 18. Selected facet values are shown below the search box, which shows the original search word. A notification above the search results informs the user that their spelling error has been automatically corrected and gives the user a choice to search with the original word.

The original search word is displayed in the search box, allowing the user to remember what they were searching for. If the user has a spelling error in their search word, the results page tells the user that results for the presumed correction are shown and gives the user the possibility to search with the original word, seen in Figure 18. This is to avoid users getting no results for their query. Showing the original word allows the user to maintain control over the interface.

3.3.4. Prototype test results

In this section the prototype test results are analyzed. First, the test tasks and their results are gone through. Then the section will go on explaining the interview results. The results of the A/B testing are reviewed and finally, the UX goals and how they were met are analyzed.

3.3.4.1 Prototype test tasks

The prototype test tasks were timed to see how efficiently the users were able to complete them. Efficiency of use is an important part of usability and in a system like search, efficiency is a very important aspect to the users. However, the simple timing of the tasks does not tell by itself how efficiently a task was completed. The participants are human and many spontaneously commented on new features or the way a feature works during the tasks. Some tasks or elements in the UI reminded the participants of issues they wanted to raise regarding M-Files. These all added to the time it took to complete a test task. Therefore, the task times are not directly comparable. The overall task times can be found in Table 2.

Table 2. Overall task times. Time shown as mm:ss.

Task	Task assignment	Min	Max	Mean	Median
1	Search for a project plan.	00:12	02:40	01:04	00:58
2	Search for an original pdf-file from 2018 about quality consultation and quality project.	00:43	05:22	02:36	02:35
3	Clear search criteria to get back to the original search results.	00:01	01:45	00:26	00:09
4	Sort the results by the newest files.	00:03	00:13	00:04	00:05
5	Go back to the homepage	00:01	00:12	00:04	00:04
6	Search for a proposal, but do not use the autosuggestions.	00:36	01:12	00:47	00:41
7	Search for a proposal made by Rosalind Dunkley	00:19	01:59	00:51	00:37
8	Search for a sales training proposal for OMCC.	00:02	00:55	00:18	00:14
9	Check out Rosalind's assignments.	00:04	02:42	00:40	00:10
10	Do you need to save searches as a view? How to do it from here?	00:03	01:16	00:14	00:08
11	Did you notice a search within field? What will happen from it?	00:01	00:58	00:26	00:23
			Total overall time	07:31	

In task 1 the users had to find information. This task proved to be difficult, mainly because the participants couldn't type in the prototype. They had to click on the search bar to get the search words to appear. This was very difficult to understand, and the participants struggled with it. All needed some sort of clarification in starting the search. Many needed encouragements from the moderator. "*How can I search for it, if I can't type?*" was a question several participants presented. This was a prototype and test-design issue that the participants will not face in real life situations.

In task 1 the participants made seven errors that came from problems with click typing. One participant thought that they couldn’t use the search box at all and started to look for the project plan from everywhere else on the front page. Another participant wanted to get the whole content of M-Files visible before starting to narrow down the search. The participants required the moderator to clarify the clicking to get the search word. After clarifications, the participants understood how the prototype worked and got the search suggestions below the

search box. Every participant used the suggestions. Three participants wanted to use the suggested word "project". However, since that did not work, they chose the "project history" found from the search history. The task took overall on average 1 minute and 4 seconds with a median time of 58 seconds.

The task times show that the participants struggled most with the task 2. On average the task took 2 minutes 36 seconds to find the correct document when the participants were only allowed to narrow down the search results by file type and the year the document was made. The median time for the task was 2 minutes 35 seconds. The participants made 16 errors in the task, which is the highest count in all tasks. Seven out of eight participants wanted to search by adding more keywords to the search box or by using the "search within" field. They explained that this was the way they would normally narrow down the search results. Sorting was also a popular way to find more information. Five out of eight users used it to find the project plan in question. Participants also tried to find either "Original" or "Quality" from the filter values. Three participants tried to use object type tabs to narrow down the results. Only one participant tried the "search options" in this task. The participants had issues with wanting to search the way they are used to searching and when that wasn't possible, they had to consider alternative ways. Some needed encouragement from the moderator to consider alternate ways to their normal way of narrowing down the results. Two participants didn't locate the filters at first; instead, they went over all other possibilities on the left side of the screen. Both had prototype A in use at their test. Another issue with the task was that the participants wanted to narrow down the search until there were only a few results left. All participants went over the search results, yet many did not really read the list. Participant 7 (P7) asked, "*Am I supposed to actually read these documents here?*" indicating that the participants expected to find the documents without reading anything. Two required encouragement from the moderator to read what was on the screen. Two participants used the snippets to find the document. Others read the document title first and then the snippet. P4 commented on the snippets: "*Here you have the information [on the documents], that is something that I like.*"

Task 3 looked at what methods the participants use to clear all filters. Five participants used the "Clear all filters" -button below the global search box. P4 spent a little time looking for a way to clear the filters with just one click: "*I shouldn't have to click more than once.*" Two participants clicked the filters away one by one. One participant clicked the search box and started a new search. One participant

clicked the "home" button to clear the search filters, which is the way it is done at the moment. This task took 36 seconds on average with nine seconds median time. Task 4 was sorting, and most participants were already familiar with the feature. Only one participant made an error with the task when they tried sorting from "search options." On average this took four seconds to complete with five seconds median. In task 5 the participants were asked to return to homepage. Three participants wanted to use the M-Files logo to return home. Five used the "home"-button. This task took on average four seconds from the participants. The median time was four seconds.

Task 6 was similar to the first task. Task 6 asked the users to search for another word without using the suggestions. The prototype misspelled "proposal" as "propsal" when clicking the search box, however, the search results were displayed for "proposal". This was to demonstrate the spelling error corrections. The participants now better understood clicking on the search box to get the search word to appear, yet they still had trouble clicking enough times to get the whole word. The participants made four errors in this task. The participants required encouragement from the moderator to continue clicking. After the participants got the search word in the search box, they all wanted to use the search suggestions to activate the search. Realizing how to activate the search by clicking the search icon required some thinking and the moderator had to encourage four participants on the task. Two participants noticed the spelling error in the word, P6 redid clicking the search word, yet as the word remained the same, activated the search. P1 noticed the spelling error after activating the search and realized that it had searched with the right word. The task took on average 47 seconds to complete with a 41 second median time.

In task 7, the participants were asked to filter with a user called Rosalind Dunkley that was not visible in the filter values. This was to test how well a filter value box with multiple items works. The participants made five errors in the task. Three participants first tried to search with alternative ways, such as going over object types or using the "search within" to write the name "Rosalind Dunkley". Again, the participants commented that they would normally refine by typing the word in the search box. Once the participants noticed the "user" facet, they had no problems finding Rosalind Dunkley from the list. "*This is good, that there is the abc-list*" commented P4. Three participants clicked on "R" from the alphabet to find her; five clicked on the "D" for Dunkley. Help from the moderator was required two times in this task, first in clarifying the test task and later to remind

a participant to think aloud. Completing this task averaged to 51 seconds with a 37 seconds median time.

In task 8 the participants were given information about the document they were searching for. They were given other criteria to narrow the results by, yet the document in question was already visible. Five participants directly filtered by the "customer" value and then found the results. Two participants found the result straight from the results list. One participant tried first sorting and then filtering before finding the correct document using their normal way of searching. This summed up to three errors. This task took on average 18 seconds with a 14 second median time.

Task 9 tested how the users understand the object types placed in the tabs above the search results. The participants were asked to search for a specific object type. Four participants noticed the object type tabs immediately and found the assignments. Three participants removed the facet "customer" first, then wondered if the results they had were the assignments. Two then went on to select the correct object type. One participant had trouble with the task and after several missteps required the moderator to remind them about reading what is on the screen. After that the object types were found. Two participants tried to open a multi-file from the search results before settling on the "assignment" in the object type tabs: "*If you can't use the arrows [in front of the files], then from here*" commented P2. On average it took 40 seconds to complete the task with 10 second median. Even though the participants were able to complete the task, they didn't fully understand what the tabs were: "*Some objects within documents,*" commented P4, "*more filters,*" was another popular response. The total number of errors made in this task was nine, indicating problems with understanding the meaning of the tabs.

Tasks 10 and 11 were more verbal tasks, asking the users if they had need for items such as saving search as a view and for searching within the search results. The participants were also asked if they understood what these functions did, and could they find them from the screen. In task 10 the participants were asked about saving their search as a view. Six participants had a need to be able to save their searches as easily accessible views. One participant was unsure about their need and one did not have the need. Four participants found the link to save the search immediately. For three participants it took a short moment. P7 wasn't interested in the task and did not start it. This constituted as an error in the task. In general, the participants liked the shortcut to creating views: "*It is better than the*

[regular] create a view, if you can do it directly from here" commented P2, "*It's quite nice*" commented P5. Task 11 concentrated on scoped search. The participants were asked if they noticed a "search within" button in the UI and if they understood what it did. "*I can search from here, if I had several results*" commented P3. Six participants found it straight away. One participant didn't think they saw it, even though they did try to use it during the task. Once they found it, they liked and understood it: "*it is really good.*" Both in task 10 and 11 a participant required help from the moderator in locating the link in question.

The issues that arose in the prototype testing were mostly prototype related. The test participants would have liked to use the search in a way they normally do. When this was not possible, the participants had to try new ways, causing more clicks on the prototype. The extra clicks made by the participants when completing the tasks were counted as errors. The number of errors per task and times the moderator was required to help the participants can be seen in table 3.

Table 3. The errors and times per task when the moderator had to assist the participants.

Task	Task assignment	Errors in task	Assistance from moderator
1	Search for a project plan.	7	8
2	Search for an original pdf-file from 2018 about quality consultation and quality project.	16	6
3	Clear search criteria to get back to the original search results.	3	0
4	Sort the results by the newest files.	1	0
5	Go back to the homepage	0	0
6	Search for a proposal, but do not use the auto-suggestions.	4	4
7	Search for a proposal made by Rosalind Dunkley	5	2
8	Search for a sales training proposal for OMCC.	3	
9	Check out Rosalind's assignments.	9	1
10	Do you need to save searches as a view? How to do it from here?	1	1
11	Did you notice a search within field? What will happen from it?	1	1

If the participants had been using a real system, the total number of errors would have been four. First error in task 3 where the participant wanted to clear the

filters by clicking on the search box. This would not have cleared the filters in the actual system. Second actual error was in task 4 when a participant tried search options for sorting. In task 8 a participant removed the filter "Rosalind Dunkley" when searching for a certain document of hers. This required the participant to re-filter by "Rosalind Dunkley". Task 9 had two errors where two participants had problems understanding the "assignment" object type.

3.3.4.2 Interviews

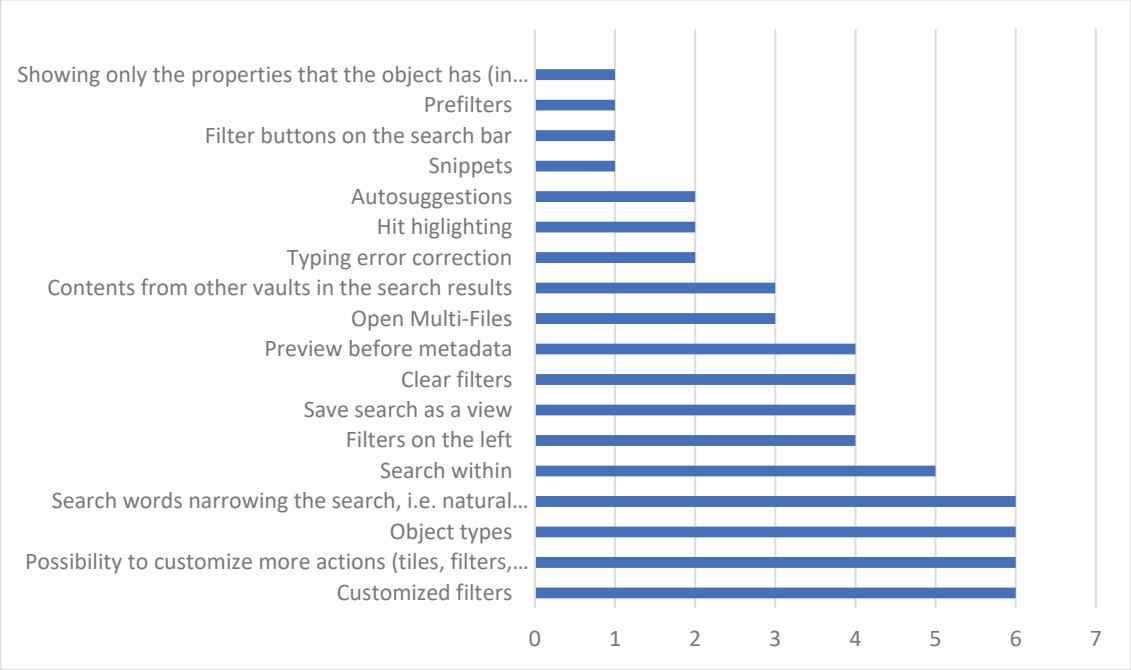
After completing the test tasks the participants were interviewed regarding their thoughts and feelings on the search. Overall, the participants liked the improvements done. Six users liked the user interface, they thought of it and the system as "*good*", "*really clear*", "*pretty simple*" and that the search "*has more choices than the current one.*" One participant was undecided, they thought it was "*different than normal.*" Another figured that the system did not have much new things for their use, other than the "search within" possibility. All participants felt that the new user interface would help them in their work. P1 commented that "*the current system is massive, you have to refine with advanced search that many can't use.*" Four participants liked having the filters available to help narrow down the search.

During the test tasks and the interview, the participants commented on some features that they liked. These features can be seen in Table 3. The most liked feature was the possibility to customize the UI. Six participants liked the idea of being able to customize the filters at least in the admin level, choose the columns that they need, organize filters according to their needs, have the choice to choose whether snippets are being shown or not, adjust the font size, and to customize the tiles on the M-Files Homepage. Having the object types visible was also liked by six participants. "*I like the object types, getting suggestions of where to choose from,*" commented P2.

The participants commented on the same thing that was noted during the second task; they want to primarily search by using only words. P2 commented that, "*I don't use the advanced search much, rather I search by using words.*" P3 commented that, "*I often search by words and drilling down from there.*" P4 simplified: "*Google is what we want.*" Three participants specified that they wanted the search to narrow down the search results if there are more words in the search box. At the moment the search gets wider for every word placed in the search box. P4 was frustrated

about this and simplified that, "*enough search words should give enough good results.*" P7 commented on the same thing: "*The more words, the more results, very bad.*" Participants would like for the search to understand the context and search accordingly. This is part of the natural language search. P6 commented that, "*if the search would search already from half a word, it would be useful. And if it understood spelling errors.*" Understanding spelling mistakes can reduce the user getting no results, as mentioned in Section 2.3. Five participants liked being able to search within results. "*This search within is good, after I get the first results*" commented P7. Other well-liked features were being able to save the search as a view from one single button and being able to clear all filters from a single button.

Table 4. Most liked features by number of responses.



Participants commented during the test that there were too many results and they were unwilling to read the results list. During the interview the participants commented on the same thing: "*so much information, so that perceiving it was… you see this text here too. In a way it is good, but when I tried to look at it and find the result, it was pretty much.*" Despite the fact that the participants thought there were a lot of things in the results list, they liked having the M-Files' own file system, multi-files, open, having the snippets for extra information and the hit highlighting to help focus on the correct words. P1 commented that the result list was "*better [than the current one], because it has more information.* P4 also said that "*It is really good that it searches [the snippet]. In that sense it is good, that it gives the idea [of the content].*" The result listing also had the documents' vault information placed in

columns, instead of separately at the end of the page. Three users preferred having the vault information visible in the columns. The participants searched for a bit before they realized where the vault, or repository, information was. P3 summarized the prototype searching the documents from all vaults: "*it is good that it shows [the vaults] I can't know in which vault the information is, so it would be good to get them to all results.*" However, the participants would also like the option to filter by vaults.

3.3.4.3 A/B testing results

The participants were asked to grade their experience on a scale of 1-5 with the new system compared to current M-Files search. For this task the current M-Files ranked as 3. The participants testing prototype A gave it a grade of 4 on average. The lowest score was 3 and the highest 4,5. These participants had the filters on the right side of the search results. Testers of prototype B, where the filters were on the left side, gave a grade of 4,13 on average. The lowest score was 3 and the highest 5. When the pilot testers' grades are added in, prototype A gets a grade of 3,43 and prototype B gets a grade of 4,07. Prototype A had a lowest score of 2 and highest score of 4,5, prototype B had a lowest score of 3 and highest score of 5. The grades can be seen in Figure 19. The reason for the bigger difference between the grades can be found from the company's own employees being more direct in their estimate. Often test participants want to be polite and not hurt the designer's feelings.

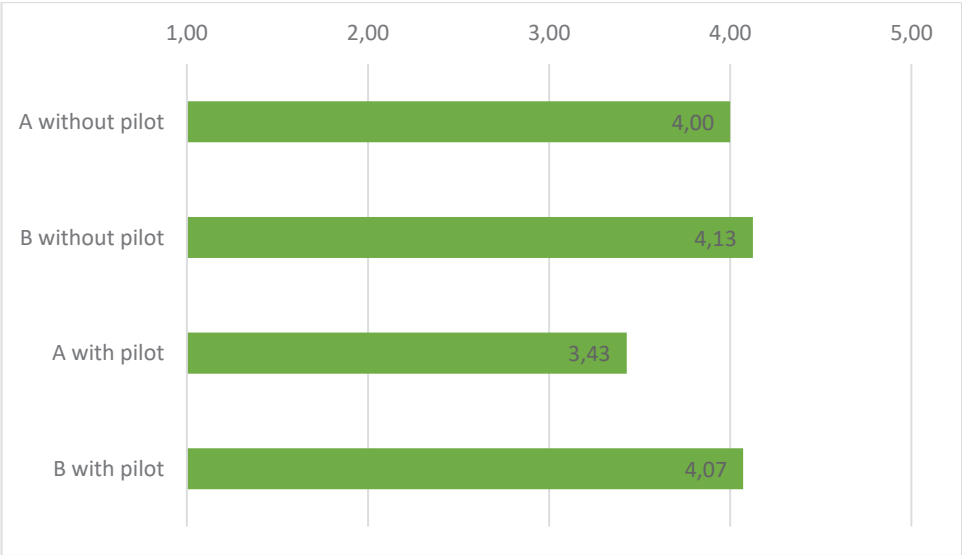


Figure 19. Prototype average grades without and with pilot testers on a scale of 1-5, 5 being the best score.

The tasks where the filters and their placement had an important role were tasks 2 and 7. Task 2 required the participants for the first time to use the filters. Completing this task with prototype A took on average 3 minutes 15 seconds and with prototype B 1 minute 58 seconds. Task 7 asked the participants to search for more values from the available filters. Completing this task averaged to 59 seconds from prototype A testers, who had the filters on the right side of the layout, and 49 seconds from prototype B testers who had the filters placed on the left side of the results. The average task times for each task can be found from Table 4. The overall average test times for prototype A were 7 minutes, 50 seconds, and for prototype B 7 minutes, 12 seconds. On average, participants using prototype B were 38 seconds faster than participants using prototype A. This would suggest that prototype B was a bit more efficient to use than prototype A.

Table 5. Prototypes A (filters on the right) and B (filters on the left) average task times. Times shown as mm:ss.

Task	Task assignment	Mean A (min-max)	Mean B (min-max)	Diff. A-B
1	Search for a project plan.	00:47 00:12 01:12	01:21 00:47 02:40	-00:34
2	Search for an original pdf-file from 2018 about quality consultation and quality project.	03:15 00:43 05:22	01:58 01:10 02:50	01:17
3	Clear search criteria to get back to the original search results.	00:38 00:01 01:45	00:14 00:03 00:33	00:25
4	Sort the results by the newest files.	00:06 00:03 00:13	00:03 00:05 00:07	00:03
5	Go back to the homepage	00:06 00:02 00:12	00:02 00:01 00:05	00:04
6	Search for a proposal, but do not use the autosuggestions.	00:46 00:36 01:05	00:49 00:36 01:12	-00:04
7	Search for a proposal made by Rosalind Dunkley	00:59 00:19 01:59	00:43 00:25 01:15	00:15
8	Search for a sales training proposal for OMCC.	00:09 00:02 00:13	00:28 00:14 00:55	-00:19
9	Check out Rosalind's assignments.	00:33 00:04 01:23	00:47 00:06 02:42	-00:14
10	Do you need to save searches as a view? How to do it from here?	00:02 00:03 00:04	00:25 00:07 01:16	-00:24
11	Did you notice a search within field? What will happen from it?	00:30 00:18 00:58	00:23 00:01 00:45	00:07
	Total time	07:50	07:12	00:38
	Average task time	01:01	00:59	00:03

Four participants, all that had the filters based on the left side of the search results, commented on the filter location. Even those participants that did not have filters in their M-Files at the moment mentioned that the filters are within easy access: "*I like that the filters are here and it's easy to sort from them*" mentioned P2. P6 commented that the "*left side is very clear, I like that I can filter from here.*" Participants P3 and P8 had filters in their current version of M-Files. P3 commented that "*In the current version the filters are on the right, I think I like them better there on the left. Feels more familiar. They are closer.*" Participant 8 wasn't sure about the filter location at first: "*The filters are [now] on the right, we are used to it, so it kind of feels like they should be there, now here is an extra bar that shouldn't be there.*" However, later on in the conversation P8 started to change their mind: "*I can hide the filters from here, but then it doesn't matter if they are there, if you can hide them when needed*" and as the interview progressed and the participant familiarized more with the user interface, the filters became the feature that the participant felt would help them most in their daily work. In the end, three participants liked the filter location immediately; one had to get used to it. During the test tasks all participants found the filters right away. Three participants went directly to the filters in test task 2, which was the first time the filters were visible. In task 7 two participants used the filters right away; two looked at other options before filtering. Task 8 brought three participants again to the filters while one participant found the searched document straight away.

The participants that had the filters on the right side also commented on the filters. P1 liked that the filters were visible all the time. P4 liked having the filters appear when the search is started as they support filtering prior to starting the search. P5 had to look for the filters a bit before locating them. P5 did not have filters in their current M-Files, yet once the filters were found, they were liked. Also P7 had to look for the filters before finding them. In task 2, P7 tried to filter by object type tabs above the search results and got frustrated when they didn't work. In this use case the filter location caused frustration and anxiety in the participant, as they were not immediately available. The participant commented that "*these are apparently part of the new thing, these filters. I do not recognize them as such that you mark them.*" P7 has filters available in their current M-Files. In test task 2 only one participant went directly to look at the filters. In tasks 7 and 8 the filter location was clearer, and three participants used the filters straight away. In task 8 one participant found the result right away without needing to narrow down the search further. It seems that the prototype UI was intuitive enough for the participants to quickly adapt to using it.

Overall, it seems that the filters on the left side of the search panel were better liked. P8's comment on already being used to the filters being on the right side supports Kalbachs' [2010b] claim about users adopting relatively quickly to unusual placements. P7's struggle to find the filters, however, suggests that before the users adjust to the unusual placement they can experience confusion, frustration and anxiety. This strongly supports placing the filters to the left side, where they are expected to be.

3.3.4.4 UX goals in the testing results

The UX goals for the improved M-Files search were clarity, ease of use and controllability. The prototype test showed that the UX goals were met. The participants found the UI clearer, though at the same time somewhat cluttered. The perceived usability had improved, and the participants felt that the filters and the tabs were easy to use, as were the "search within" and "save search as a view". The results listing gave more information enabling for easier recognition of the correct result. The different ways to refine the search gave the users control over the system.

Clarity helps the users to complete their desired actions and to organize the content in a way that has meaning for them. The increased feedback to the users by showing active filters in a separate information box and making object types visible in tabs above the search results were liked and used by the participants in the prototype tests. Also creating clear work areas by keeping all the search functions on the left side of the layout and the document functions on the right side of the layout helps the users to focus on their tasks. A user interface that follows common search practices and standards helps users achieve their goals faster, as was proven with the different filter locations. Having filters placed by the standards, on the left side, allowed the participants to complete the tasks 38 seconds faster than the participants who had the filters placed on the right side of the layout. Participants commented that the new UI was clearer than the old one, giving more choices to the user to refine their searches. Despite the UI being clearer, the search results listing was still cluttered, and the participants commented on it being crowded. This still requires work for the next iteration; how to clarify the results more while still giving the users the refinement options they need.

The second UX goal was ease of use. Users require an intuitive user interface to minimize their cognitive load and to help them focus on the items they are searching for. Incorporating autosuggestions and error corrections to the search helps the users to recall the items they are looking for instead of having to remember them. Error corrections allow the users to make small spelling errors and still find what they are looking for. All prototype test participants used, or wanted to use the autosuggestions. Writing more accurate search requests is a natural way of searching and this is what the prototype test participants wanted to do. Having the system understand natural language search queries eases the user's burden to find just the right search word. The users also do not want to go over several search results to find the correct one, they want to refine their search to a few results. Enabling this answers to the user's needs. Even large quantities of facet values can be handled when they are designed intuitively and following the standards. The prototype test participants did not have any problems with finding the user Rosalind Dunkley even if she wasn’t visible within the first 20 user names. Since the main idea of M-Files is that the users can find data by its content instead of where it is stored, the users shouldn't have to worry about in which vault the data is. When the search goes over the whole M-Files content and all its repositories, giving all of the results in one list, this promise is fulfilled. The participants in the prototype testing liked having all the results in one listing, and not having to remember in which vault the information is being stored.

Users like feeling in control of the system and having the system work for them. Controllability was the third UX goal. Different users want to search in different ways. Even if many users refine their searches with filters, not all users want this. P8 in the study saw the filters yet avoided using them in the prototype testing for as long as possible. Allowing for different types of users and different ways of searching and refining gives the users the control over their search and the comfort of being able to work in a way suitable for them. Allowing the users to personalize some of the features gives them the freedom to choose what they need for their professional needs and the feeling of control. Possibilities for personalization need to be studied more: what personalization options can be given to the admin user and what to the final users. Users also want control over the amount of information given to them in the result listing. They, in general, do not want many results, yet they want the option to have more results shown. Participants in the prototype testing wanted to narrow the results down to as few as possible, though at the same time they wanted to look at more results if the ones that were on the screen were not to their liking. Allowing for the users to

influence the amount of results and information shown gives the users the control to choose what they want.

4. Discussion

Search is a tool that most people use without giving it too much thought. As long as they find what they are looking for, they are satisfied. If the search does not work in a way the users are accustomed to, or it does not generate the correct results, users get agitated.

User behavior in connection to web or eCommerce searches has been studied quite extensively. This study, however, focused on studying usability and user experience of document search. This aspect of document search has not been studied as widely, which required interpreting and adapting the existing research into a new field. The study focused on M-Files, which is an information management system with emphasis on easily locating documents. M-Files is meant for business use, which notably affects the usage scenarios. The context is work-related, usage is expected to be efficient, and the users are not able to choose whether or not to use the software.

The standards used for improving the M-Files search are based on usability guidelines and user experience goals. These were incorporated into the existing M-Files design guidelines. The UX goals generated based on the user questionnaire were clarity, ease of use and controllability. A prototype was created based on these goals and usability best practices and tested with eight M-Files users. Testing with users from different backgrounds allows for a set of varied use cases to be evaluated.

The testing situations always differ from the user's normal way of working and many participants are careful about too much criticism as they do not want to hurt the designer's feelings. This has to be taken into account when planning and analyzing the prototype tests. The employees of the developing company can be the loudest critics. They should be heard, yet their opinions should not be the only ones to be studied as their point of view can considerably differ from that of their customers.

Testing a prototype poses certain difficulties, which may affect the outcome of the test as the prototype is different than a normal system. In this study, the participants were not able to type in the prototype, causing some confusion with the tasks the participants were expected to complete. Additionally, the prototype did not have all the available functionalities enabled. This caused some issues and

participants were hesitant to try some things, as they were unsure what would work and what not. This affected the efficiency with which they were able to adapt to the prototype and to use it. In future prototype tests a practice task for participants should be added to help the participants to familiarize themselves with the way the prototype functions before moving on to the actual testing. A different UI with similar functionalities as the test prototype should be created for the practice task. This would ensure that the prototype testing captures the first impressions of the participants on the new UI.

During the prototype testing the participants often started talking about a whole different matter, which affected the task timing. Many of the errors found during the prototype testing were prototype-related and not applicable with the actual system. These considerations had to be taken into account when evaluating the prototype test results. Ideally the UX goals and how well they were met should be analyzed both qualitatively and quantitively. Quantitative measurements ensure that the results are valid, there is a numerical base for them, and the results are not just someone's conclusions [Budiu 2017]. However, in this study, the limitations in the prototype made the quantitative metrics inaccurate. Therefore, it was decided to put more emphasis on qualitative data to avoid false conclusions from unreliable measurements.

All in all, the prototype testing showed that the UX goals were largely met, yet there was still room for improvements, such as increasing the clarity by more careful design and enabling more personalization features to give the user more control. As this study focused on one system only, there are also some limitations to it and its results. To be able to generalize the results, the study should include more document software, such as Google Docs, OneDrive and Salesforce. The user questionnaire was answered only by 35 people from Finland. A global, more extensive study should be carried out to reveal more information on the way search tools are used. The prototype testing participants in this study were all either advanced or basic users. This means that the new users were not included in the testing at all.

Existing research suggests that expert users tend to give higher usability scores than novice users [Kortum and Johnson 2013]. This can influence the overall scores the participants gave during the prototype testing. Also, the participants all use M-Files at least on a weekly level. Users that use the software monthly or less often can have different user experiences. This study included A/B testing;

however, the participants saw only one UI, instead of testing them both. This may also affect their opinions and ways of using the software.

This study has benefitted M-Files and will be used to develop M-Files' search further. M-Files is a specialized software solution developed specifically for storing and effectively accessing large quantities of documents. The use case is quite different from more generalized search engines like Google. Therefore, it was beneficial to include the actual users of the system in addition to the literature review and usability guidelines. Based on the feedback from the prototype testing the participants were satisfied with the results and this indicates that targeting the UX goals towards M-Files users helped to improve the perceived usability.

The next phase is to iterate the prototype based on the prototype test results. After the iteration, the new version should be tested again. This time the test users should come from a more varied background and include new users. This is to ensure that the new search is suitable for all users, not just the experts. After the iteration is done and the prototype satisfactory, the implementation of improvements can begin.

M-Files is available also on mobile devices. This study, however, focused on the desktop version as it is the most common way of using the software. The current mobile application is simpler and has less advanced functionality, like facets. Metadata is prominently shown while the hierarchies, or relationships, of documents are behind another link. As the mobile application is so different from the desktop version and its use context more varied, the findings of this study do not directly apply to mobile platforms. Future work should be done to expand the scope of the research to mobile applications.

This study has clearly indicated that by listening to the users, their experience while using the software can be improved. When designing for the end users, it is good to know who they are and how they work. M-Files has a large customer base with several different types of users and use cases which naturally applies to a number of other document systems as well. In their design, it is important to take into consideration the several needs of their varied users. This can be done by allowing the users to have more choices over their way of working while keeping the user interface clear and uncluttered. It is also important to understand and speak the users' language. The user interface should have elements

that are named in a style the users understand and features that the users know how to use. Even small changes can have a big effect on the way the users experience the system. Adding an informative breadbox on active filters gives the users more information and a new way to control their environment. Changing the amount of results can give clarity to the users and giving more visibility to existing elements can make refining the results easier.

There is a clear research gap on how the use of internet search tools have affected people's attitudes towards using search in different types of software. The use of internet search has increased over the years to a point where Google is used over 40,000 times per second [Internet live stats 2018]. Both the user questionnaire and the prototype test carried out and analyzed during this study showed that the users are willing to use search and they want to use different searches in the same manner as they use Google. They also expect to get accurate results with a minimum effort. To be able to achieve this, modern search engines require artificial intelligence in the background interpreting the user's search queries and context. Despite the AI working in the background, attempting to better understand the user, the search user interface needs to allow the user to refine the search results for easily locating the correct result.

Another issue to study further is how the technology of web searches has influenced the development of search tools in document searches. According to Tech Crunch [Lardinois 2018] Google is planning on releasing a search service to businesses to provide a better search engine for them. When this happens, more businesses might be using Google technology and their searches will be acting more like Google. This creates an interesting phenomenon in searches outside of web search engines and would make an interesting study on users' attitudes towards search in the future.

Despite the limitations, this study has brought forth new information on how people use M-Files search and how they want to use document search in the same way they are accustomed to using Google. This study is in line with previous research on usability of search tools and it can be used as a basis for expanding research to the field of document search. The study was conducted and documented according to ethical norms stated by Lazar et al. [2009, 376-388]. The results of this study are based on careful analysis of the user questionnaire and the prototype test, and they answer the research question that setting UX goals for the search can help improve the usability of the search.

5. Conclusion

This study has focused on the usability of document search and on ways of improving it. The study has aimed to study the best practices for document search and to improve M-Files search by following said practices and by setting user experience goals according to the users' needs. The main objective of this study was to see if user experience goals could be used to improve the usability of M-Files' search. This was done by asking the users about their use of M-Files search and finding the pain points in the system. From these, three UX goals were derived: clarity, ease of use and controllability.

Existing research regarding search usability concentrates on web searches and eCommerce sites. Document search and its usability is not a widely studied area and the research in the field is lacking. This study brings together the existing best practices of web search and uses them successfully in a document search. Utilizing the theory and the UX goals, a prototype of an enhanced M-Files search was created. As there was some discrepancy about the filter placement, two prototypes were made: prototype A with the filters on the right side of the layout, and prototype B with the filters on the left side of the layout. The prototypes were evaluated by users of M-Files in their work places. Both prototypes were well liked, although somewhat cluttered. Prototype B, with filters on the left side of the layout, got better ratings from the users and the participants found the filters easily. The overall task completion times were on average 38 seconds faster than with prototype A. The prototype testers liked both prototypes better than the current version. This indicates that setting UX goals for the design process helps improve the perceived usability of a document search.

The UI was designed to be clearer with more choices to the user. It enables the use of natural language in search queries and has error corrections and autosuggestions to allow for ease of use. Making the available functions more visible and the design more intuitive made the new interface notably easier to use. Enabling the users to search and refine in different ways and allowing for personalization gives the users control over the system. The prototype testing showed that the UX goals were largely met. The prototype testers felt that the user interface was clearer, the available functions were visible and within easy reach. Those who wanted to search with filters could easily do so while those who wanted to search with words had options to refine the search by more search words.

Due to the lack of research on usability of document search the UX goals and prototype design were based on research of the usability of other search systems. The good results of the prototype testing indicate that this was a valid hypothesis; to some extent the same practices apply to document search that apply to web search. This also shows that users are accustomed to using search. Moreover, they expect other searches to work like they do in Google. When the other systems do not work like a web search does, the users get frustrated. By enabling web type performance, the system supports the users' existing behavior.

Despite promising results, future studies in this field are still required. More information on users' needs regarding document search would clarify the best design practices and help create guidelines for designers working within the area. It is not known how well the current results can be applied to mobile applications with smaller screens and touch based input. Thus, more research on the search functionalities, filters and user interface elements is needed in the mobile context. Academic research is required on how much web searches and eCommerce sites have affected the users' ways of using different searches and how these should be taken into consideration outside the internet.

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Appendices

Appendix 1 - User questionnaire

User Experience Survey on M-Files Search

Welcome to our survey about your experiences in using M-Files search.

The answers gathered via this survey will be used as research material in a master's thesis on M-Files search. Your answers are invaluable to us and will be used to further improve the usability of the search functions in the M-Files software. The survey takes about 10–15 minutes to complete. We kindly ask you to please be as detailed as possible.

Your answers are evaluated anonymously, and your information will not be connected to your answers.

We highly appreciate your input and the time you are taking to help us in making M-Files even better. If you have any questions regarding this survey, please contact helena.hornborg@m-files.com.

Background Questions

1. How long have you used M-Files?

- Less than 6 months
- Less than a year
- 1-3 years
- 4-6 years
- Over 6 years

2. What is your skill level with computers in general?

- Basic user (basic word processing and browsing the Internet)
- Intermediate user (you master the basics and have developed additional skills, including the use of different software)
- Advanced user (knowledgeable of hardware and software, able to solve problems and advise others)

3. Do you feel confident using M-Files?

- Yes
- No

4. How often do you use M-Files?

- Several times a day
- Once a day
- A few times a week
- Monthly

5. List the most important things you utilize M-Files for. Please mention at least three items.

6. Is there anything else you would like to say about M-Files in general? Criticism and praise are both equally and very welcome.

Using M-Files Search

7. How often do you use the search functions when you are using M-Files?

- Always
- Usually
- Rarely
- Never

8. What other methods do you use for finding documents? Please also explain why you prefer these methods over using the search functions.

9. In what kind of situations do you use the search functions?

10. When you are searching for something, do you know exactly what you are looking for?

- Always
- Usually
- Rarely
- Never

11. Please give a few examples of your typical searches.

12. How important for you is the ability to search for content in M-Files?

- It is definitely the most important part of the software.
- It is among the most useful features in M-Files.
- It is a nice feature, but I could use the software without it.
- I would probably not notice if it was removed from the software.

13. Is there anything else you would like to say about the M-Files search?

Ways of Searching

14. Please describe the steps you take from starting the search to finding the correct result.

15. How often do you use the following?

Search options (opened from a button beside the search field)

- Always
- Usually
- Rarely
- Never

Additional conditions (Can be found within the search options)

- Always
- Usually
- Rarely
- Never

Pre-search filters (Filtering the search before conducting the search)

- Always
- Usually
- Rarely
- Never

Search Results

16. How often do you find what you are looking for with your first search query?

- Always
- Usually
- Rarely
- Never

17. How long does it usually take for you to find the correct item?

- Immediately
- A few minutes
- Roughly 5 minutes
- Closer to 10 minutes
- The item is never found

18. How clearly are the results displayed in the search results?

- Extremely clearly
- Very clearly
- Not so clear
- Not at all clear

19. Do you need to refine your search results?

- Always

- Usually
- Rarely
- Never

20. Is there anything else you would like to say regarding search results?

Filters

21. Does your version of M-Files support filters?

- Yes
- No, please move to question 26.

22. How often do you use filters for refining the search results?

- Always
- Usually
- Rarely
- Never

23. Which are your three most used filters?

24. Are there any filters missing that you would need in your daily work?

25. Is there anything else you would like to say regarding the search filters in M-Files?

General Questions

26. What are the best things about the M-Files search?

27. What would you like to see changed in the search functions?

28. Please give any other feedback you might have regarding the M-Files search.

Willingness to Participate in User Testing

28. Would you like to participate in testing a search prototype that has been designed based on your answers? The test session takes a maximum of one hour and will be organized in October. If you are interested, please enter your phone number or email address on the following page. Your contact information will not be connected to your answers.

- Yes
- No

29. Please enter your contact information if you would like to participate in testing the prototype.

- Name
- Company
- Postal Code
- Email Address
- Phone Number

The test session takes a maximum of one hour and will be organized in October. We will contact you about the session during September or October. Thank you for your participation.

Appendix 2 - Informed consent form

CONSENT TO RECORD A USABILITY TEST

We ask you to participate in a usability test which aims to improve the usability of M-Files Search. The usability test is also a part of a thesis for the University of Tampere by Helena Hornborg. By participating in the usability test you will help us to evaluate the new version of the usability of the M-Files Search.

You will be asked to perform different tasks using the prototype and to think out loud while doing the tasks. In addition, we will we will interview you about the use of the prototype. The test will be recorded.

During the test, we will record the computer screen and its events by a screen capture program, and audio by the program and a separate microphone. The materials recorded during the test will be used to evaluate the usability of the M-Files search prototype in the thesis and to improve the M-Files search. The recordings will be destroyed after the design is complete.

The results of the test will be reported anonymously. A summary of the main results will be presented in the thesis. Video or audio recordings or participants' personal data will not be revealed.

You can stop participating in the usability test at any point.
We are happy to answer, if you have any questions.

By signing this form, you will accept the above terms.

Date and place: _____

Signature: _____

Name clarification: _____

Appendix 3 - Semi-structured interview questions

Interview questions

Background questions

- Are you tech-savvy?
- Do you feel confident using M-Files
- Do you use M-files a lot in your daily work

General questions

- In overall, how was the experience of using this search?
- What are your initial thoughts on this search user interface and it's functionality
- Did you get a good idea of the search functionalities?
    - Why/why not?
- Would this user interface help you achieve your goals/ in your work?
- On a scale 1-5 how was this experience compared to current M-Files Search

- What was good
- What was bad
- What was different compared to the current search
- What are the things you would definitely want to see implemented in the search?
- Personalization
    - Filters (company, standard)
    - Metadata/preview

Any other questions, thoughts or comments come to mind?