Arium

Beyond the Desktop Metaphor

A NEW WAY OF
NAVIGATING, SEARCHING, AND ORGANIZING
PERSONAL DIGITAL DATA

Jungwon Roy Shin

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Introduction

Anyone who owns a computer today also owns literally millions of digital files. How does anyone find a specific file among the millions? It's no trouble when we know exactly where a file is, or its full name, but this information is easily forgotten. And since digital files don't exist in physical space, it's easy to get lost looking for them.

This problem is only getting worse as our individual digital storage capacity grows faster than ever, and our digital context is moving from individual computers to the cloud, which is even more conceptual and invisible. Moreover, most of us currently own multiple digital devices that have a decent amount of digital storage and access to cloud services. As a result, our digital files are even more dispersed, and are shared with more and more people.

This is the starting point for my thesis. Given the massive number of digital storage and cloud computing services, the folder system is no longer the best way to store information. We are confused about where to save information, how to name our folders, and where to search for them. The parent-child relationship within the folder system no longer works best to manage our digital data. What could replace this metaphor, so we can retrieve files easier and faster?

The limitation of the desktop metaphor : what can take its place?

Since the first personal computer arrived in our homes in 1970s, the progress of technology has accelerated faster than ever. As the cost of computing parts has fallen, they have also become miniaturized, and their efficiency has increased significantly. These changes resulted in the birth of various types of micro-sensors and enabled the mobility of digital products. This evolution has allowed us to own multiple devices and to access our digital archives from anywhere.

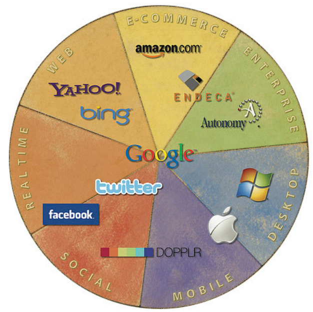
Additionally, the emergence of cloud computing and social network services have enabled us to easily share more files with more groups of people. These new digital contexts have changed our digital behavior significantly. Now our digital data exists in multiple places and its ownership has merged with others. We keep files in digital archives that others use, and we value shared image and music files we did not create in our collection.

Before I started my journey to find a new paradigm beyond the desktop metaphor, I needed to clarify my project goal and specific context. In my literature review, I found three main activities we perform on our digital files : navigating, searching, and organizing. Across multiple operating systems, the desktop metaphor has maintained the same properties within these three behaviors. We name files and folders by our own categorizing rules. We save files inside folders and nest folders by order. Depending on how we create the relationship between folders and files, the quality of these three activities changes. The relationship between files is critical—therefore, I believed this was the right starting point to transcend the current desktop metaphor. I decided to rethink, break, and change this relationship by framing my project around finding a new way of navigating, searching, and organizing files.

New ways of navigating, searching and organizing personal digital data

Once I established this goal, I found that I needed to define the parameters of my project. The purpose of searching is significantly different, depending on whether a user is finding or discovering. Finding is about tracking. There is already a sort of relationship between me and the object. Discovering is learning. We explore and hunt for the object. By defining personal digital data as any data that has a relationship to me, I eliminated the category of search as discovering. Files created by others, but shared with me will also be regarded as personal digital data. Documents sent via email, images I am tagged on, and links shared with me are easily accessible on the cloud service and will fall into this context. With this scope in mind, I turned to a literature review to help me identify challenges and establish a clear purpose for my thesis.

My thesis is not about problem-solving, but rather it is about finding opportunities. My process was focused on not just designing one singular product to replace the desktop metaphor, but rather designing ways to guide other designers and developer out of thinking the conventional way. I hoped my suggestions and ideas inspire those visionaries to gradually replace the desktop.



The primary colors of search, Search Patterns

' The primary colors of search' helps us to understand different categories in search. Morville and Callender who created this figure, claimed that we need to embrace a set of proven technologies, business models, user behaviors. Within the primary colors of search, my context will cover from blue(Desktop), violet(Mobile) to red(Social).

From past to present

Historical Research

To begin my thesis work, I decided to focus on finding links from the past that might help me predict the next steps for the future. I started my historical research from 1980s when the personal computer was widely commercialized. This research helped me to understand how digital devices, internet services, and computing software have evolved, and how these evolutions have changed our lives. Then I read recently published articles and journals to find emerging issues in the current computing industry. I also researched user needs in managing digital data. Understanding both how technological improvement and user needs affect progress, and relating this knowledge to current issues enabled me to find design opportunities.

A. The first personal computer, 1981

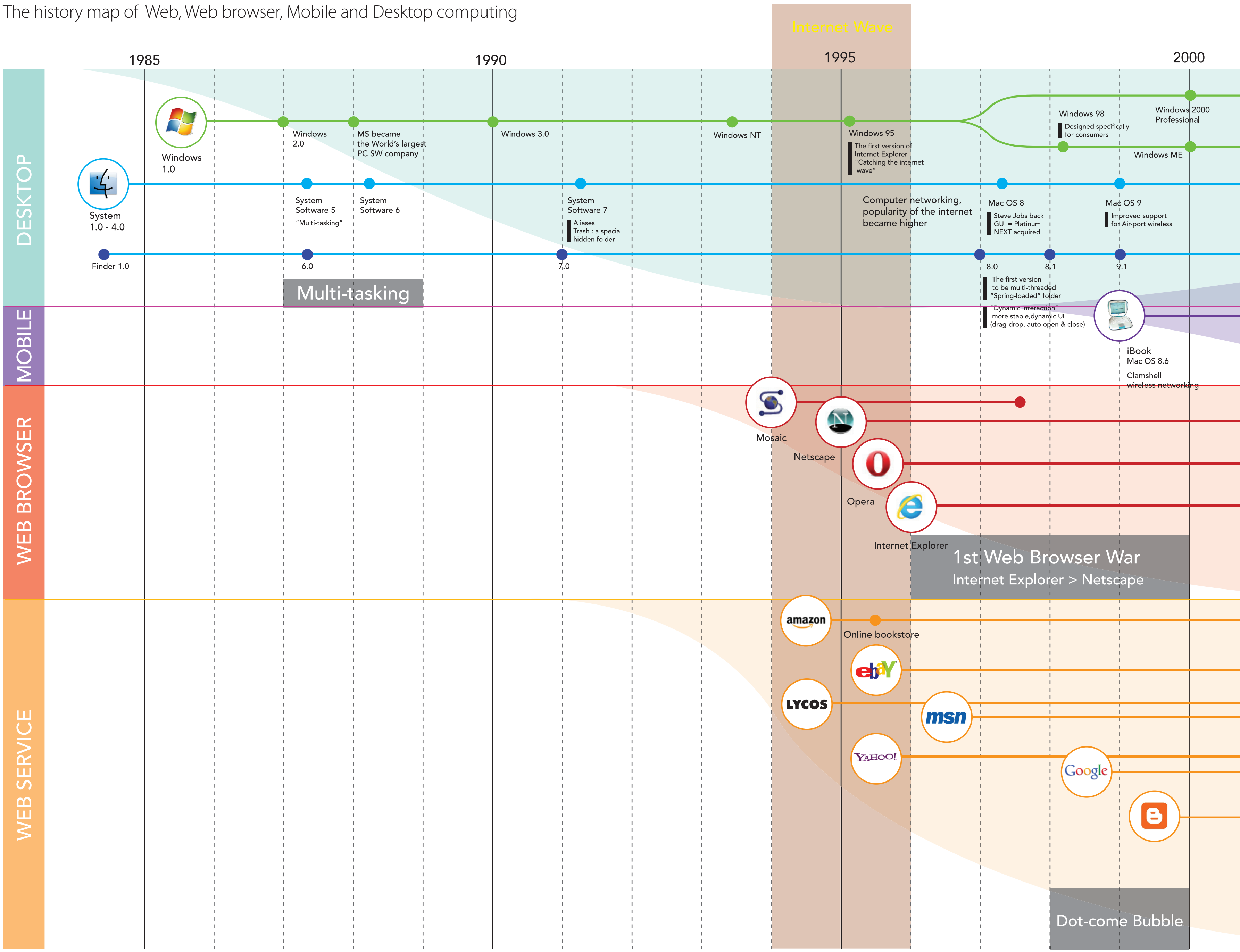
The first personal computer[a], IBM 5150—regarded as the first "home computer"—arrived in 1981. The IBM 5150 was equipped with an Intel 8088 4.77MHz CPU, 256kB of memory, and was available with one or two 5-1/4" floppy drives. Now, 30 years later, the latest Apple MacBook Pro has a 2.5GHz CPU (on average), 8GB of memory, and a maximum of 750GB of storage capacity.

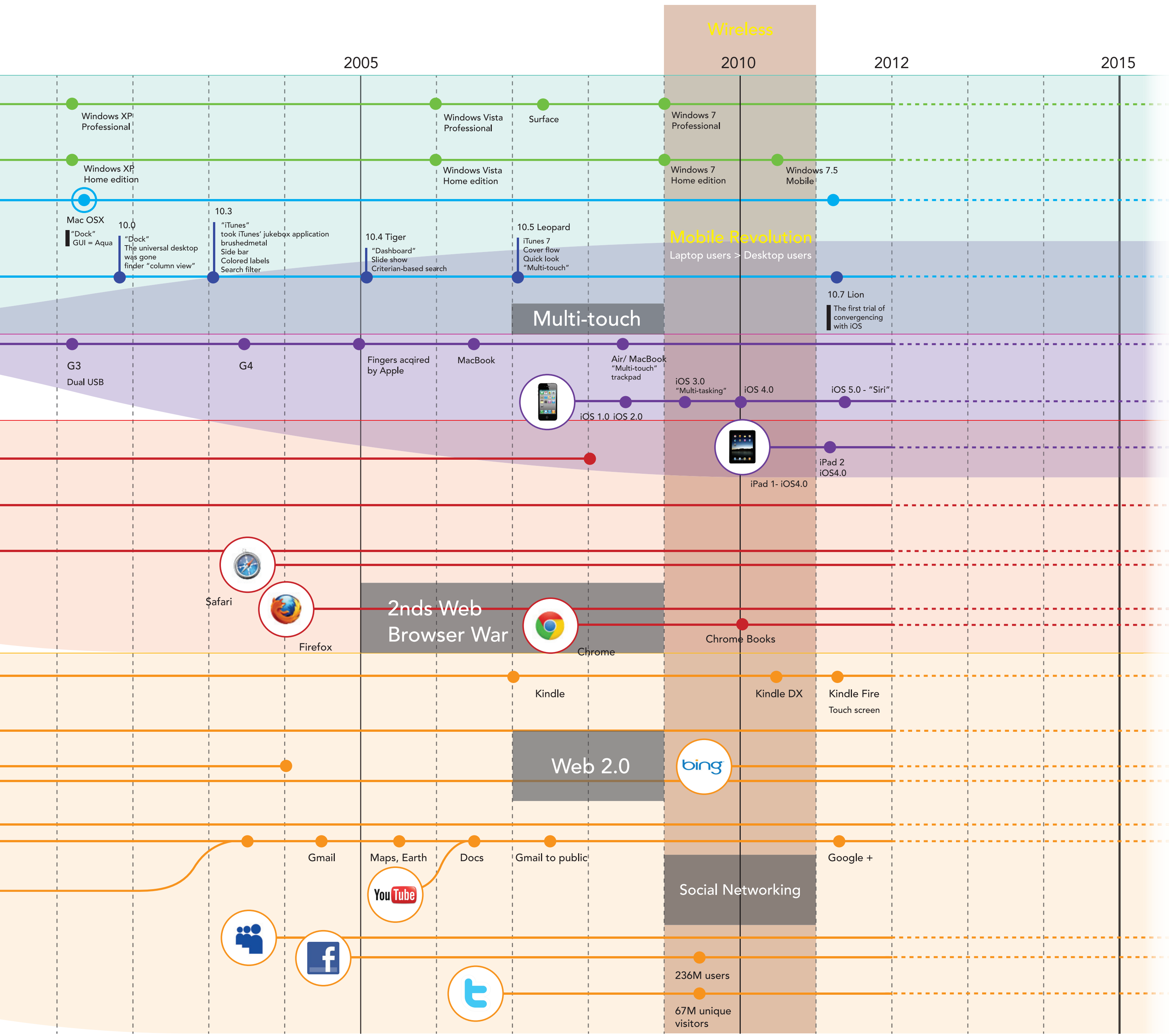
These technical improvements over the last thirty years have caused broad changes in our lives. Massive amounts of storage and powerful processors have enabled us to create a file without any size limit, and the ability to manage millions of files. Additionally, the micro-size of hardware parts gave the devices both mobility and sensibility. Various types of digital devices such as laptops, smartphones, and tablet PCs have emerged because of these improvements. The advancement of sensibility has enabled devices to perform in new ways: to interact with our gestures and voices, locate their current position, and collect massive amounts of data related to user behaviors using background processes.

IBM 5150 (www.extremetech.com)

[a] The first consumer computer is Scelbi & Mark-8 Altair & IBM 5100 Computers in 1974. However, IBM 5150 is the first home computer had no technical distinction from business computers.

The history map of Web, Web browser, Mobile and Desktop computing





Wireless
2005
2010
2012
2015
Windows XP Professional
Windows Vista Professional
Surface
Windows 7 Professional
Windows XP Home edition
Windows Vista Home edition
Windows 7 Home edition
Windows 7.5 Mobile
Mac OSX
"Dock"
GUI = Aqua
10.0
"Dock"
The universal desktop was gone
finder "column view"
10.3
"iTunes"
took iTunes' jukebox application
brushedmetal
Side bar
Colored labels
Search filter
10.4 Tiger
"Dashboard"
Slide show
Criterian-based search
10.5 Leopard
iTunes 7
Cover flow
Quick look
"Multi-touch"
Mobile Revolution
Laptop users > Desktop users
10.7 Lion
The first trial of convergencing with iOS
Multi-touch
G3
Dual USB
G4
Fingers acqired by Apple
MacBook
Air/ MacBook
"Multi-touch" trackpad
iOS 3.0
"Multi-tasking"
iOS 4.0
iOS 5.0 - "Siri"
iOS 1.0 iOS 2.0
iPad 2
iOS4.0
iPad 1- iOS4.0
Safari
Firefox
2nds Web Browser War
Chrome
Chrome Books
Kindle
Kindle DX
Kindle Fire
Touch screen
Web 2.0
Gmail
Maps, Earth
Docs
Gmail to public
Google +
Social Networking
236M users
67M unique visitors

B. Internet wave, from Web 2.0 to Web 3.0

On April, 1993, CERN[a] announced that the World Wide Web (WWW) would be available to anyone, free of charge. With the introduction of the first graphical web browser—the Mosaic web browser—in 1993, the WWW enabled the spread of information over the Internet through an easy-to-use and flexible format. Now, in 2012, about a third of the world's population uses the internet every day, and the WWW has become our most important medium for education, entertainment, and business.

[a] European Organization for Nuclear Research

The history of the WWW has evolved from the prosperity of e-commerce in the mid 1990's to the invention of powerful of search engines in late 1990's, and then, to the emergence of social network services in the mid-2000's. The exponential success of e-commerce sites such as Amazon and eBay persuaded people of the promise of internet business, and this resulted in the dotcom bubble. However, companies who built applications were more likely to survive the dotcom bust. In addition, powerful internet search engines increased the number of internet users, and encouraged them to form online groups around their interests. This phenomenon helped social network communities emerge. Since the founding of Blogger, Myspace, and Facebook between 2000 and 2005, a number of new social networking services have been introduced, engaging more and more people.

As these social networking services flourished, Tim O'Rally coined the term "Web 2.0," at the original Web 2.0 conference[b]. Web 2.0 is centered on harnessing collective intelligence. Collective intelligence applications depend on managing, understanding, and responding to massive amounts of user-generated data in real time[c] : real-time search, real-time response, and real-time feedback. Real time is not limited to social media or mobile applications, however—we vote, purchase, and find directions, among many other activities—and the internet supports all of these activities. As result, the current web performs powerfully in collecting our information and responding in real time. Now we need to think about how we will filter these massive amounts of data and access the exact information we are looking for.

In 2006, the idea of the Semantic Web, regarded as Web 3.0, was suggested by Tim Berners-Lee. The main purpose of the Semantic Web is to shift the current web paradigm by enabling users to find, share, and combine information more easily. The current applications and search engines on the internet are very helpful, so we go to the web to carry out tasks such as finding a dentist's contact information, reserving a table at a restaurant, or searching for the lowest price for a DVD. However, machines can not accomplish all of these tasks without our direction, because web pages are designed to be read by people, not machines. The Semantic Web, as originally envisioned, is a system that enables machines to "understand" and respond to our complex requests, based on our meaning. Such an "understanding" requires that the relevant information sources be semantically structured, a challenging task. To design data as machine-readable, specific models were suggested: Resource Description Framework (RDF), Web Ontology Language (OWL), and Extensible Markup Language (XML), among others.

The movement from Web 2.0 to Web 3.0 implies the reconsideration of how data is structured, and this idea became very important to my thesis. Web 2.0 is centered on gaining as much data as possible and sharing it as fast as possible—and Web 3.0 suggests that the data structure needs to be rebuilt so we can make these massive amounts of data useful. How to organize these data so we can access them easily then became a key focus of my thesis. I felt that further research into this concept was necessary to my project, and this research is outlined in the following chapter.

[b] now the Web 2.0 Summit.

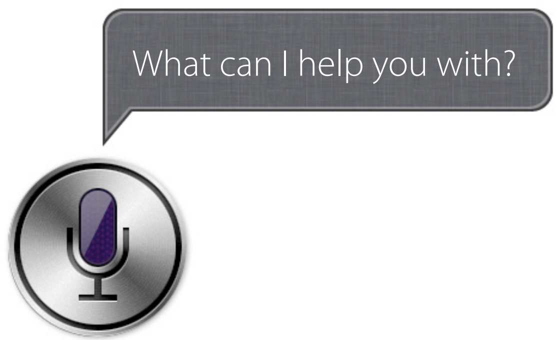
[c] O'Reilly, Tim., Battelle, John. Web Squared: Web 2.0 Five Years On. Web 2.0 Summit. 2009. Conference

C. From query search to intelligent assistant

Yahoo, Google, and other internet search engines opened the paradigm of keyword search. Keyword searches helped users find information faster and more easily. Through the use of these search engines, massive amounts of data became both accessible and searchable, not only using the title of the file, but also with words included in the file. Digitized information was easily retrieved by search engines, and consequently, lots of information moved from print to online formats. People no longer needed to look in the Yellow pages, encyclopedias, and dictionaries for information anymore.

Over the last five years, the search paradigm has evolved. Search queries have expanded from keywords to image, audio, and GPS data. Search engines have become smarter—they now understand various types of queries, are enabled to provide a concise answer, or take further actions instead of merely providing a list of results. For example, Siri, a voice interaction search service on the latest iOS, understands its user's purpose and gives them the best choices. Siri can find the best pizza restaurant nearest the user, find your friend's phone number in your contacts and text him, and many other tailored responses to the user's query.

Siri is not the only example. Google Goggle can search information and translate words into different languages with a photo. Shazam can find the title and musician of the song you're listening to. To develop these types of applications, complex algorithms in data processing and advanced electronic parts in sensing must be designed. For this thesis however, I wanted to focus on the interaction between users and these smart applications and how they have changed our daily activities, rather than the progress of technology. The change in how we interact with, and what we expect from, search engines will be discussed in the following chapter.



Siri, Apple Inc.

D. Mobile revolution

When digital cellular networks—"the second generation (2G)"—started replacing the analog networks of the early 1990s, cell phones trends moved away from the larger brick phones toward tiny hand-held devices. 2G introduced SMS (text messaging) and the ability to access media content on mobile phones. This change caused an exponential growth of cell phone users and familiarized people with text-based communication data and media content on the cell phone.

The next breakthrough in mobile life was the emergence of wireless networks, or Wi-Fi. WiFi is a technology that allows an electronic device to exchange data wirelessly over a computer network, including high-speed Internet connections. Wi-Fi enabled stationary devices to be mobile and communicate with other devices constantly. Before Wi-Fi, internet access required a computer that was wired with a cable connected to the wall. However, people with Wi-Fi do not need to stay close to the wall anymore. They can go to any area that supports Wi-Fi with their computers. This change means that people have become more mobile, have large amounts of data storage, and the ability to do complex tasks anywhere.

The global success of smartphones in 2007 became an important turning point for personal mobile life. A smartphone expanded its user's personal communication into social activities, and changed their roles from consumers to producers. Smartphone users contributed to the growth of media industry by producing, sharing, and broadcasting music, images, and videos they created. This trend was fueled by the emergence of social networking and multi-media sharing sites.

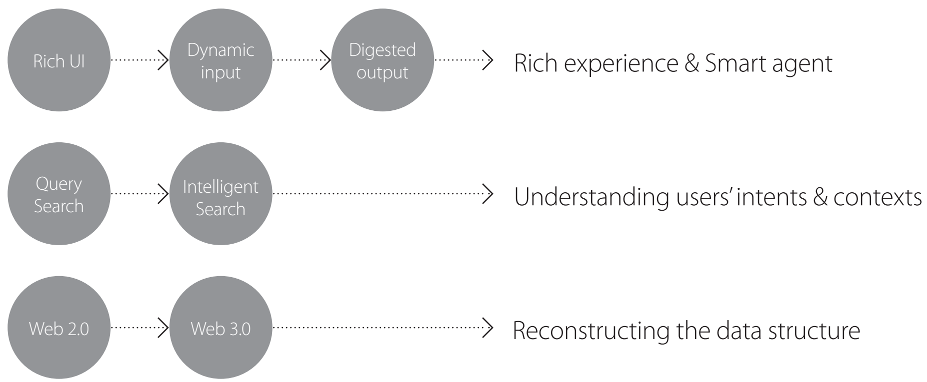
Cloud service has also changed the way we share and store digital data. Cloud computing refers to applications and services offered over the internet. Examples of cloud computing are online backup services, social networking services, and personal data services. Hardware services, such as redundant servers, mirrored websites, and internet-based clusters are other examples. The cloud computing tructure allows access to information provided that an electronic device has access to the web.

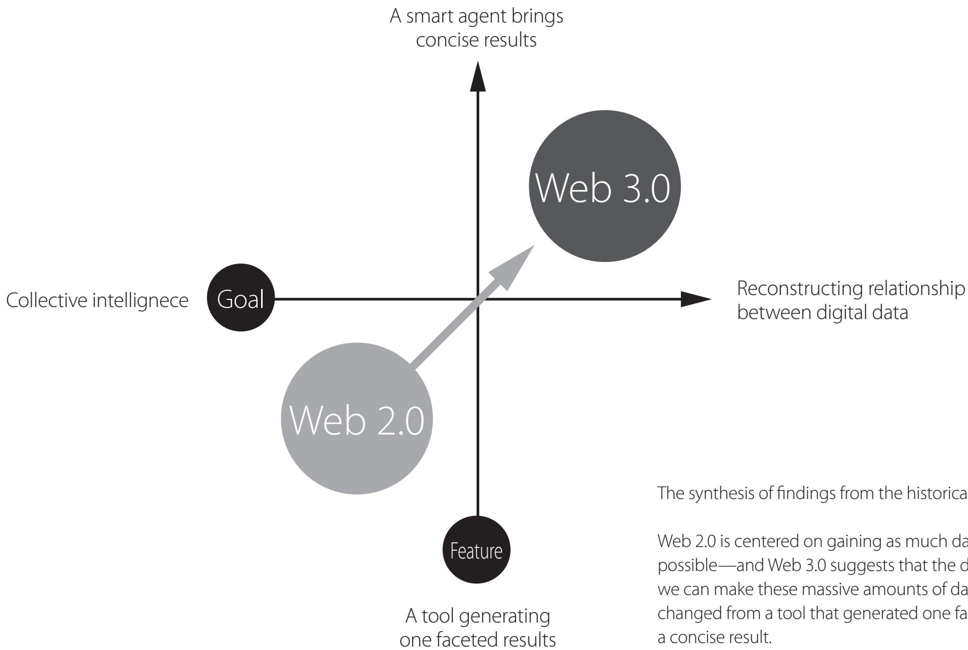
This revolution in mobility and accessibility has blended the ownership of files, and has minimized the importance of where we now save our files. The fact that we need to manage more data—even the data created by others, but shared with us—and keep our tasks across different computing devices demonstrates the necessity of converging mobile and desktop contexts. It means that we need a unified operating system, or a platform which can organize these "everywhere-files," made by everyone.

E. Findings from the historical research

By following the history of the web and researching computing industries from early 1980's, I learned how our digital context has evolved. I pinpointed noticeable events or turning points in each of the industries: desktop, mobile, and web, and it helped me see the links from the past to the present.
I synthesized my findings into three categories: multiple interactions and a smart agent, reconstructing data structure, and understanding user contexts.

From these findings, I discovered a paradigm shift that has been emerging in two areas: search and data structure. Our computing devices have changed from being tools which generate singularly-faceted results to smart agents that understand our intent and bring digested results. Also, our goal to manage digital data has changed from merely collecting, to a deeper consideration of its relationship to us.
I believed these two areas needed further research, which would then help me to find design opportunities.





The synthesis of findings from the historical research

Web 2.0 is centered on gaining as much data as possible and sharing it as fast as possible—and Web 3.0 suggests that the data structure needs to be rebuilt so we can make these massive amounts of data useful. Also, our computing system changed from a tool that generated one faceted results to a smart agent that offers a concise result.

What I focused and where to go

Current issues & Design opportunities

I followed up my historical research by exploring the current issues and trends in computing software and data managing systems. Based on the findings in the historical research, I wanted to look closely into recent changes of the search paradigm and the movement to reconstruct the data structure. Also, I wanted to find research around user behaviors in organizing electronic data to get inspirations for my final design.

My literature review covered a range from exploring current issues and design opportunities to user research. I read 20 books, 44 articles including 17 research works and latest news related to the desktop metaphor. Given the number of rigorous user research studies already published about this subject, I focused my initial research efforts on combing through papers and reports authored by professionals in the computing industry and academia. In my literature review on user research, I focused on what hinders users in searching and organizing their digital data. Thomas Malone's user research helped me understand user behaviors related to the physical desk. From Mark Ackerman and his colleagues' research, I learned about our tactics and preferences in searching digital data. Malone's work was from the 1980s and Akerman's work was from the early 2000s -comparing the two, I could see how user behaviors changed and the research focus moved from the physical desktop to the digital one. Carolyn Rosé and Naman Gupta collected massive amounts of clickstream data to analyze how well users perform search on the internet. It gave me a good insight into the fact that search is challenging because users do not know what to find, not because the search engine can not find it.

Since devices and software are becoming smarter and user expectations are getting higher, professionals in data management argue that we have to change our perspective on search so we can create a better search systems. Supporting this argument is the fact that, compared to people in the 1980's and 1990's, people nowadays generally do things differently on computers than they used to. The invention of powerful search engines has encouraged people to search by keywords in the desktop context in a way people in the 1980's and 1990's did not.

To support the new paradigm of search, a change of data structure is necessary. As I found in the previous chapter, there is a movement to rebuild the data structure as semantic and networked, in order to make the most use of digital data in a search. Metadata is the most important resource to build a data structure. Metadata is information about the data, and we can not identify any digital data without it. In the following chapter, I will look into what metadata is and how we can utilize it better.

A. Search, a wicked problem

[a] Slocum, Mac. *Search is the WEb's fun and wicked problem*. O'Reilly Radar. 2010. Online Journal

In an interview with Mac Slocum, Morville claimed that search is a process of learning and works best as a conversation. Its process is iterative, interactive, and offers rich opportunities for learning. For instance, when we go to Amazon to purchase a digital camera, it suggests related searches and displays a dynamic, personalized map to a user's search results. This helps the user to formulate the right questions, instead of serving up answers. In addition, search relies on languages as a bridge and a few keywords can not provide enough insight into the user's intent. This is why search is a wicked problem for designers.[a]

The context that Moville discussed is not exactly same with my context, since his search was about discovering, not finding. However, his point of view in search process is important to notice. How we search personal digital data is also iterative and an interactive experience. To find a file, we have to navigate multiple folders and external digital storages, or we use internal keyword search engines. This iterative experience is about reminding our memory about the file and this process is similar to the formulating the right questions. Fortunately, finding personal digital data is not only relying on languages, the contextual information related to the file is very useful for us to recall where we saved it or what we named it. The search process by other resources such as why we created it or who we worked with, will facilitate this iterative and interactive experience to be more desirable.

Search patterns

Rose and Gupta's research work[b] was very interesting to look at. They researched how data mining and machine learning technology support novice internet users during web-based information seeking. The goal of their project was not directly related to my thesis, but their user research and findings gave me an insight into why we are easily frustrated when we search. Their targeted audience was novice computer users and non-native English speakers. Rose and Gupta found that a low comprehension of English, which is a primary language in the internet, may act as a hindrance in formulating effective search queries.

[b] Gupta, Naman K., Rose, Carolyn P. *Understanding Instructional Support Needs of Emerging Internet Users for Web-Based Information Seeking*. Journal of Educational Data Mining. 2010

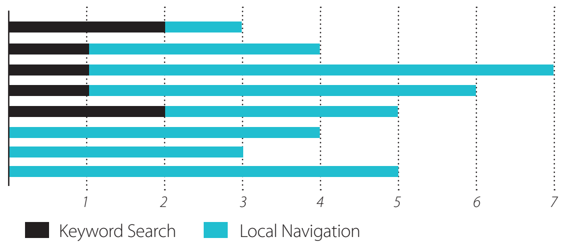
This finding lead me to wonder, "Are non-native English speakers the only people who have trouble creating effective search queries?" My answer is "No." Similar to their findings, native English speakers also have a low comprehension of language. While the users in her research had difficulty understanding the literal language, we, as English speakers, have difficulties understanding the context of language. For example, say I want to use the internet to find a good dentist near my home. I need to specify my search with where I live, what my problem is, and the cost of treatments, et cetera. All this background information is necessary to find the right information. However, we do not know all of this background information when we need to learn or explore new things that we have not experienced yet. This lack of knowledge, or context, hinders our search experience apart from any limits of the search engine.

[c] Alvarado, Christine ., Teevan, Jaime., Ackerman, Mark S. Karger, David. *Surviving the information explosion*. The MIT Press. 2003.

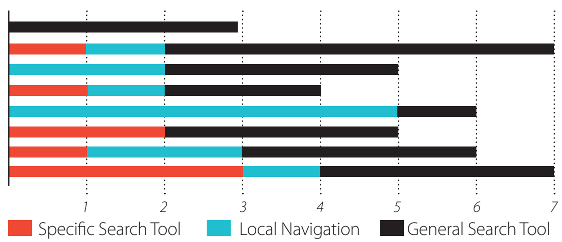
Research work by Alavarado and his colleagues[c] in the Artificial Intelligence lab at MIT, identified two types of strategies in search tactics: orienteering and teleporting. Orienteering is localized and situated navigation. Orienteering involves using contextual information to narrow in on the actual information target, often in a series of steps. On the other hand, teleporting is direct arrival to the information we are looking for. Akerman found that even when people could use their contextual information to teleport directly to their information target, they often preferred to orienteer to the information instead. This indicates that people orienteer rather than teleport because they do not trust more specific contextual searches.

This finding about users' preference for orienteering and using contextual information is directly related to my thesis, because it helps identify how current tools are not in tune with users' preferred behavior. The current file system is not supportive of orienteering behavior. The navigation in the file system is only moving between parent and child folders, while orienteering is approaching to the destination from multiple directions. In addition, the internal search tool on the computer does not allow users to take advantage of contextual information to specify what they are looking for. If users do not remember the name of the file or folder, keyword search on the internal tool is useless.

The number of times participants used each search tactic in their files



The number of times participants used each tactic on the Web.
Note that pilers appear to use specific search tools more often



* Surviving the information Explosion: How people find their electronic information

B. Metadata

Metadata is often called "data about data" or "information about information." Metadata facilitates search and retrieval. Metadata is commonly stored in a database system and linked to the objects described. Metadata can be created either by automated information processing, or by manual work. Basic metadata captured by computers often includes information about when a file was created, who created it, when it was last updated, file size, and file extension. The term metadata is used differently in different communities. Some use it to refer to machine understandable information, while others use it only for records that describe electronic resources.There are mainly three types of metadata: descriptive, structural, and administrative metadata. Descriptive metadata is information that describes a resource for purposes such as discovery and identification. It can include elements such as title and keywords. Structural metadata indicates how compound objects are put together, for example, the structure of computer systems such as tables, columns, and indexes. Administrative metadata provides information to help manage a resource, such as when and how it was created, file type and other technical information, and who can access it.[a]

[a] National Information Standards Organization. *Understanding Metadata*. National Information Standards Organization Press. 2004. Print

What it means to us

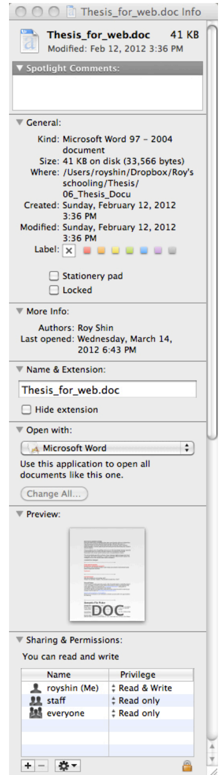
Metadata is key to ensuring that resources will survive and continue to be accessible into the future. Even though it helps systems perform information retrieval, we do not often look at the metadata associated with our digital files. The process of collecting and organizing metadata is conducted on the operating system, and we do not have a choice about what information is collected, but we can add additional entries into the data scheme.

Figure[a] is a 'Get info' view of a file in Mac that shows the file's metadata. Computer-savvy users might find this information and add Spotlight comments to enable a better keyword search. However, most typical computer users only pay attention to the title, date of creation, or the size of the file. Metadata is an important resource to information retrieval, so how can we utilize this for everyone?

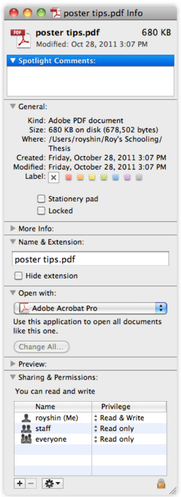
Different representations and interpretations of metadata have started showing up in productivity applications and e-commerce business on the internet. For example, most of our applications such as Office, Adobe series, and computer operating systems have "recent" or "history" features to easily access the files we use most, and track specific files we used. This is based on metadata. "Suggestion" is also a different interpretation of metadata—for example, YouTube and Amazon use metadata to provide suggestions to their users based on their activities and preferences.

The synthesis of all these findings from my research on the history of computing, current issues, and user search needs led me to identify design opportunities: data structure, user contextual information, and search preferences. In this thesis, I suggest a new conceptual model of the file system based on these opportunities.

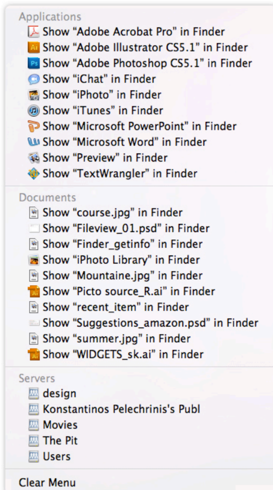
Figure[a]



Different representations and interpretations of metadata



the view of "Get info"



Recent Items

Suggestions, Amazon

C. Design opportunities

My research and exploration of current search issues helped me identify three design opportunities. First, the current tree structure is a primary factor that limits searching and navigating activities on the digital desktop. Having to keep climbing up and down the folder system is time-consuming and confusing.

Secondly, a file can belong to only one folder unless it is duplicated, and this limits accessibility for the user. Meanwhile, contextual information has lots of potential to be a new type of metadata that has rich information about the user, such as what the file is for, who the user shares the file with, and how the user accesses the file. This creates a certain relationship between the user and the file.

Finally, our perception of search needs to be changed. The traditional model—a simple question and answer—is not flexible enough to meet the user's demands. The latest search engines are already capable of understanding dynamic input and providing digested results. It is not surprising anymore to discover and search information by taking a photo, playing a song, and talking to the device. The new model of search should be able to support these iterative and interactive experiences.

i. Data structure: the "Folder metaphor"

A tree menu is a taxonomy and general trait of our consciousness. We categorize an object in order to understand it, putting it into categories and subcategories. This is a conventional file system which uses the folder metaphor—a parent-child relationship—limited by the fact that a child can have only one parent.
Yet in the real world, an object is not classified in only one category. This characteristic of a taxonomical structure limits the current file system. One document has multiple topics, relationships with people, and projects. By categorizing this document into one folder, we easily forget where it is, because one title of the folder can not represent the full intent of the file. Ironically, taxonomical data structure is centered on where to look for files, but instead we get lost in its hierarchical structure trying to find "where it is."

Ontology is a newly arising idea to replace the current taxonomical file system. An ontological structure is a linked or networked file system. Its structure is graphical. This is a natural approach to memory and knowing. When we recall an event, we use various information to recall it, such as the time, location, and people we hung out with. The relationship of different attributes clarify how to track the object we look for.
In the ontological structure, an object is cross-listed in multiple categories. Also, the structure is so flexible that objects can be grouped in faceted hierarchies. For example, we can sort a group of files alphabetically, chronologically, or in different types.

The taxonomical structure has already started breaking down in certain contexts. The data structure in mobile devices and social networking services is a hybrid between taxonomy and ontology. In iOS, there is no folder, and instead files are tied to each application and shared by multiple applications. For example, an event on a smartphone's calendar can be wired with a text file, contact information, and alarm settings. A photo in Facebook exists not only on my timeline, but also on others who are tagged in the photo, or its creator.

Taxonomy

Hierarchical view
Relationship between
a top level category & subcategory
Conventional file system

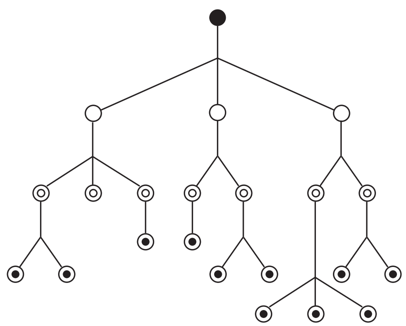
WHERE to look for files

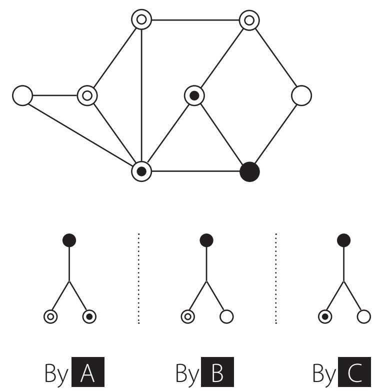
VS

Ontology

Graphical structure
Linked/ Networked
Cross-listed multiple categories, characteristics
Memory triggers, intuitive knowing

HOW to look for files





ii. Contextual information : What has meaning or value?

The metadata currently collected provides technical information about the file. It reveals only functional relationships between a file and its owner. Many typical users do not get much use out of this metadata as they navigate and search their electronic files. As I discussed in the previous chapter, different representations of metadata are very helpful in allowing users to understand and use it. Collecting additional information as part of metadata is also necessary. To make metadata more friendly and supportive, the user's contextual information with the file can be another source of metadata. Contextual information that implies a user's current activities, schedule and collaboration with peers would empower the relations between files and a user and provide more useful information to the user.

Let's bring back the findings from the research work by Alavarado's team. We use our contextual information as a guide in navigating locally in small steps to the desired document. To make this experience more useful and enjoyable, our machine should collect various types of information that make more sense for the users. For example, the machine knows who the user shares the file with via email and Dropbox, what songs the user usually listens to when he is working on it, what project it is for, and when the project is due via the calendar.

iii. Search preferences, a conversation

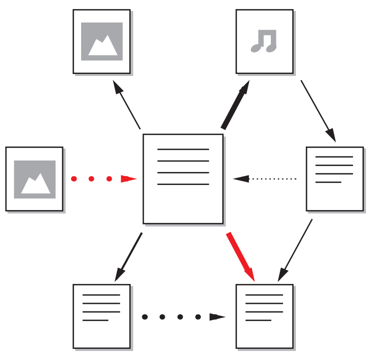
As I discussed above, search is a iterative and interactive experience like a conversation. Finding a file is similar to a single topic conversation. It stays in a boundary and leads to the endpoint. When we discuss about one topic, we want to have a conclusion we all can share or agree. It is enjoyable to approach to the endpoint from different directions but each direction needs to converge at one point.

As a single topic conversation ends with a conclusion, finding personal digital data ends with a file we look for. The way that we approach should be enjoyable and we want to get closer by each step. As we categorize and narrow down to conclude in a conversation, we have to be able to scope down the result of search in this process.

D. New model : Social ontological data structure

Networked files are pointing each other

The networked data structure as fully ontological has been suggested by lots of companies and researchers, but there is no product embedded within that structure. Isn't it interesting that we still use painful folder-and-file data structure even though we believe the ontological data structure is more ideal?
It is easy to visualize the ontological structure when we explain what it is, so why is it hard to realize it as our file system?



Social ontological sata structure

I think the flexibility of the ontological structure is helpful for creating meaningful relationships between objects, but it is also very problematic because rules, categories, and priorities are constantly changing.
We do not feel comfortable with something that keeps changing because we can not predict it. Especially, when we are searching and exploring, we want to remember where we came from so we can go back in case we chose the wrong direction. How about having a set of rules to navigate flexible and changeable structure so we can always predict what is coming in the following step?

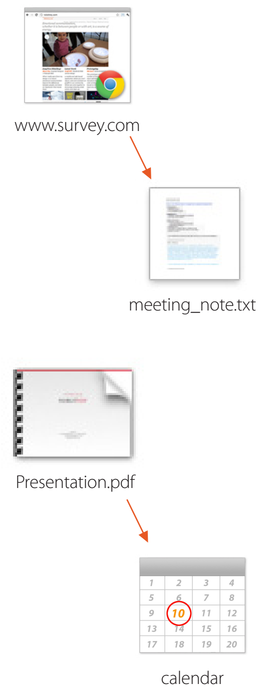
The model that I want to suggest uses the ontological structure, but it is also based on the social relationships between files. There are certain rules about how files are connected to each other and how strong of a relationship they have with others. In this model, files point to other files based on certain rules. This implies a social network between digital files like the social network between people. We follow friends on Twitter and get feeds from friends on Facebook. Some friends are in the close friend circle, some friends are in the classmate circle and other people are in the work circle. Even though we have hundreds of connections in our social network, there is a unique relationship and shared history with each person.

i. Relates files according to a user's usage

Most files have a relationship with other files. For instance, a document contains links, images or text referred to in other files. The same document can also be published in a different format, creating yet another relationship. According to the user's usage, the sequence of your work will create the relationships between files.

The social relationship between files still relies on the user's usage. The relationship can be created not only by the sequence of usage, but also by the file's context. For instance, a user has different types of files with different purposes for one project. The group of files could be a note the user took in the meeting, websites the user visited for market research, and a PDF file for his presentation. All these files have a social relationship in the circle of the project and point to others based on their importance and relevance. If the meeting note was taken during a survey on the internet, the visit history on the web browser can point to the note file. If the presentation file is a final piece for the presentation, the file can point to the schedule information on the user's calendar.

The user can navigate faster in this networked structure, and also be guided by looking at where the files are pointing. By exploring the path of file connections, the user will be likely able to find what they are looking for. If the user wants to go back to the starting point, he only needs to follow the pointers back to the start.

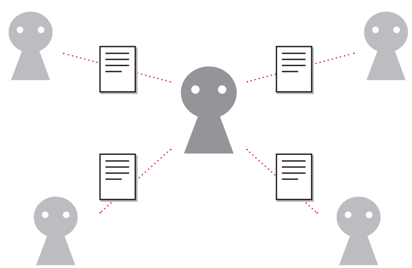


ii. It knows why you're looking for it : learning the 'use' context

The social (sociontological) structure weights the relationships between files based on the user's context: which projects the user worked on, when he created files, how long he had worked on them, where he brought files from, and who he share them with. Weighted relationships between files will create new priority rankings among files. This social data structure will suggest the most likely file to its user, based on these rankings. There are lots of properties that can be collected in the context of use. Our digital activities mainly fall into four categories:

1. People: We receive and send files via email, messenger services and Dropbox. Most of the files are shared with other people we work with. We also have different relationships with other people, and this information characterize the files for us: is the file shared with my classmate, my family, or a manager at work? Depending on who we share files with, the meaning of these files can be significantly different.

2. Project : Most of our tasks belong to projects. Is it a home remodeling project, or is it a project for clients? The purpose and goals of tasks also differentiate the relationship between a user and his files.

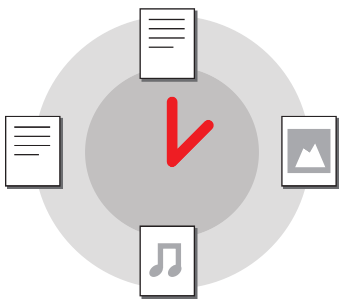


People

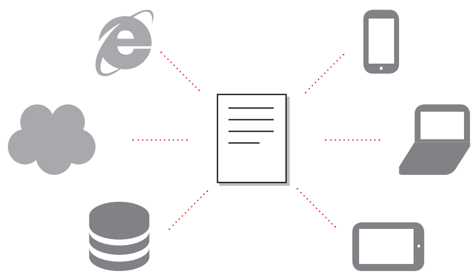
Project

3. Time : Some tasks are urgent, and some tasks come back to the user at a certain time. The lifespan of digital files is different for each file. Some files are time-sensitive, while others might remain untouched for a long time. Lifespan refers not only to the file's creation date and when it was updated, but also to the strength of its relationship with its owner.

4. Device : We create files across devices—from mobile phones, to the laptop, to cloud services on the Internet. We record images and voices with digital cameras, and download files from external hard drives. When all devices are networked, managing digital files becomes more frustrating. But, if a file stores the history of where it has lived, we could easily track where it came from. Even though a digital camera names photos with cryptic numbers, we can find out what camera the photos are stored in, and how we have managed them.



Time



Devices

Ȧrium,
beyond the desktop metaphor

Envisioning future

As I begin this chapter, I want to reiterate the goal of this project: envisioning new ways of navigating, searching, and organizing personal digital data. From my literature review and user research, I defined navigating, searching, and organizing as the three main activities we perform on our electronic files. I found design opportunities from historical research and current issues, and suggested a new model of data structure. It was at this point that I presented my mid-way project poster to faculty of the School of Design and the public. I received a number of interesting comments from various types of people. In general, people believed the social ontological data structure is promising to overcome the limitations of the desktop metaphor. Also, people were fascinated to tell me about their own frustrations in organizing digital data and their own strategies to solve problems.

In this chapter, I will introduce a new file system based on my model. For each of the three activities, I will present my insights, and propose an idea to create the file system.

A. Navigating:

The static desktop is dead

My research on the digital desktop environment in the 1980's and 1990's was mainly focused on observing how people organized their physical desktops and tried to find solutions by applying their findings into the electronic desktop. Malone's user research about how people organize their physical desks demonstrated that people usually put most important files on the top of the pile or leave them in a noticeable spot. This finding inspired researchers and developers to explore new ideas: Freeman and Gelernter designed Lifestream [a], and Karger created Haystack [b].

However, the location and noticeability of a file is not as important as it used to be, since users are so familiar with keyword search to find the targeted file. Just look at how we use our home screen on the desktop: in the past, we placed urgent files or files-in-progress on the home screen so we could easily access those files. Now, we place unimportant files or temporary files that we don't mind losing on the home screen. Some of us decorate the home screen and leave no files on it. Since our memory about the urgent files or most recent files are vivid and the current search tool works well with a file's name, the keywords search gives us faster and easier access.

What could be more efficient to access important files or the files we want to remember?
Among the personal stories that I was told during the poster sessions, I found interesting behaviors that I also tend to follow:

"I email an important file to myself, so I can be reminded later."
"I leave important emails as unread."

Why is emailing such a powerful way for us to keep up with important tasks? It is accessible across devices—it has a stream of conversations, collaborations, and updates. Also, locating messages that are most recent on the top and highlighting messages that are not opened yet works very well for people. I thought that having this interaction on the home screen on our desktop was a good idea. Instead of a static, inactive, meaningless current home screen, an interactive and frequently-updated home screen would become a powerful gateway for its users to access any files.

[a] Freeman , Eric., Gelernter, David. *Beyond Lifestreams: The inevitable demise of the desktop metaphor.* The MIT Press. 2007

[b] Karger, David R., *Haystack: Per-user information environments based on semistructured data.* The MIT Press. 2007

The home screen on my personal computer, Jungwon Roy Shin, 2012
Files on this screen are unimportant and temporary.

B. Searching :

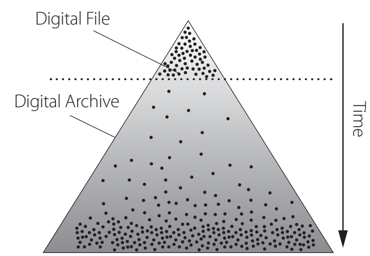
Dive into the bottom of the pyramid

Searching for old files is even more difficult. When we don't remember where we saved a file, we have to go through quite a few folders and sift through redundant file names. Since we create lots of duplications and poorly defined names of folders and files, we have to spend a lot of time tracking down the files we want. Keyword search become even more painful in this case. No matter how powerful the search engine is, a number of files and folders with similar names mess up the results list. Here is another story:

"When I redid my portfolio this year, I had to spend so much time to find images and text files I used for the previous portfolio."

This is not only her story—all of us have the same frustration when trying to find files sunk down into the pool of data. We want some files to come up to the surface of the pool, while we never look back at other files. In particular, certain tasks we need to recall only occasionally need to be well organized and carefully named so we won't have any problem finding them. In cases where we revise files over time but still need to keep the history of the file, it becomes even more confusing to figure out which file is newer, and see the number of versions.

The social ontological data structure will decrease our frustration in finding these old files. Since the structure was created by the social relationship between files, it will lift up all related files to the surface, and then guide us based on the aspect of relationship we are looking for. For instance, if I want to update a PDF file I created a year ago, I only need to pull out a piece of information about the project. The file system will bring up all related files, and I will end up with the final PDF file when I follow the path that each file is pointing to.



This is a pyramid I visualized the perception of a digital file and its owner by time. Old files are sinking to the bottom of the archive, while recent files stay the top of the digital archive so it's easy to access. For the owner, finding an old file is like diving into the dark and deep part of his digital storage. Instead of diving into the pool of data, fishing out a file will be easier and faster. However, what could be the most attractive bait? or what could be most powerful rod that can reach as far as to the bottom or detect the target in the dark?

C. Organizing :

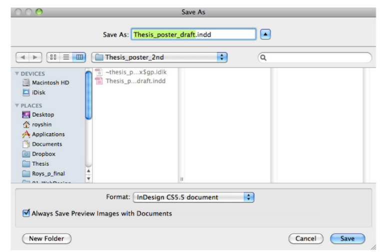
Memory fades away

Everyone has their own rules for organizing digital files and folders. This rule reflects an individual's context and personal preference. Our context and personal habits keep changing, while the environment of our digital devices remains as we created it. This is why we have to spend lots of time figuring out where we saved a file that we are looking for after some time has passed. These are stories describing the uncertainty people feel about their own rules:

"I sometimes don't know what folder this new file should be saved in."
"When I name a file, I'm not sure if I would be able to find this file later."
"I have rules in organizing folders, but it is somewhat flexible so it is confusing me when I track back a file."

The main problem in organizing our digital files is that we continue to break our own rules. We easily forget our rules, or make another rule because we think it makes more sense at the moment, or we can not apply the rules anymore because our context has changed. For instance, a student organizes folders by year, by class, and then by the projects. However, when the student graduates and starts working in a company, the same rules will not work to manage her files. She would create a master folder called "work," and categorize files in each project folder.

How can the file system reflect our changing personal rules, or have a perfect rule the user can apply in all cases? My idea is to forget it. If we do not have any rules, then we have nothing to break. Why a file should be in a folder and the folder should be nested? If we can locate a file in multiple folders or multiple containers, we just need to find this intersection of containers—thus making finding and organizing files much easier.



The current 'save' browser. The screen shows the taxonomical file system. We need to think about what is the most important fact to remember when we save. The location in the hierarchy? I think we should be able to save our contextual information when we save a file.

A tour of Arium

My thesis proposes a new paradigm for file management called Arium. Arium is a file management system. The data structure of Arium is social ontological. Files are networked through their social relationships. These social relationships are created based on their owner's activities. Each file points to other files, and in turn, is pointed to by others. When a file is newly modified or updated with a new message, it broadcasts its update so its owner is easily notified. Instead of a Folder, Arium has a "Keepr". A Keepr is a collection of files. In Arium, a file is able to belong to multiple collections—as opposed to the current paradigm, where a file can belong only to one folder in a user's desktop. For instance, the personal resume in Word format will be pointed to by the user's contact info, profile photo, or educational certifications. This file will point to the final resume in PDF format. The collection of contact info, a photo and certifications can be kept by "Resume" Keepr. Also, the final PDF file can be tied to "Resume", "Job"' and "May 2012". When a file is tied to Keeprs its owner chooses, Arium regards it as "collected."

Arium is a platform that can exist across devices and in the cloud. It can exist in a virtual server, or become a surface that can access personal archives from certain devices. It is networked with other services such as email, social networking, and cloud storage services, and it provides unified notifications to its users. This collected information across external services will contain such powerful contextual information that it will enable Arium to create social relationships between digital data and their owners.


06:20am
CREATE NEW FILE
Presentation-nov-2012.doc
x3 Sarah, Clarence, Jessica
11:30am Seminar : Presentation
Latest: 4.9.2012/ Created: 11.2.2008
Mockup_004.psd
Sarah "Hi Roy, could you have..."
Roy Shin 2 hours ago
Latest: 4.9.2012/ Created: 11.2.2008
Ethics and Robotics
www.ethicsandrobotics.poster....
Shared with Wes Johnson
Saved: 11.2.2008 1:35pm
IMG_418 ~ 987.jpg (569)
Canon G10
Pittsburgh, PA / Mountain View..
4.9.2012 - 5. 11. 2012
Thesis_document02.doc
Sarah "Hi Roy, could you have..."
Roy Shin 2 hours ago
Latest: 4.9.2012/ Created: 11.2.2008
Thesis_document_final.pdf
Sarah "Hi Roy, could you have..."
Roy Shin 2 hours ago
Latest: 4.9.2012/ Created: 11.2.2008
Thesis_document_02.doc
Sarah "Hi Roy, could you have..."
Roy Shin 2 hours ago
Latest: 4.9.2012/ Created: 11.2.2008
IMG_0012 ~ 0197.jpg (185)
Roy's iPhone
Seoul, South Korea
2.14.2012 - 2. 18. 2012
Electronic & House. playlist
256 songs in iTunes
Shared with Kevin
Plays: 23 / Latest: 2 days ago
Poster_design01.psd
sent to: Clarence Yung
Harry : a week ago
Latest: 4.9.2012/ Created: 1.28.2012
Cool design portfolio
www.robotroy.com
Saved: 11.2.2008 1:35pm
Qolt_project proposal.pdf
sent to: WesJohnson@gmail.com
downloaded: 3.12.2012
Latest: 4.9.2012/ Created: 11.2.2008
Jazz collection. playlist
107 songs in iTunes
Shared with Kevin
Plays: 184 / Latest: 4 days ago
IMG_0001 ~ 0012.jpg (12)
Roy's iPhone
San Francisco, CA, USA
2.14.2012 - 2. 18. 2012
User research_draft.pdf
Gill "Please make sure if you..."
sent to: Alice Hanry via Gmail
Latest: 4.9.2012/ Created: 11.2.2008
[Web]Class_schedule.doc
x3 Chongho, Wes, Jessica
3.22.2012 3:30pm - send it to Rach
Latest: 3.29.2012/ Created: 1.2.2012
Roy Shin_cover letter02.pdf
Mark Choi : 4.3. 2012
Latest: 3.29.2012/ Created: 11.2.2011
Roy Shin_cover letter.pdf
Mark Choi : 4.2. 2012
Latest: 3.29.2012/ Created: 11.2.2011
[Web]Class_schedule.doc
x3 Chongho, Wes, Jessica
Roy Shin_cover letter02.pdf
Mark Choi : 4.3. 2012
Roy Shin_cover letter.pdf
Mark Choi : 4.2. 2012

A. Streaming home screen

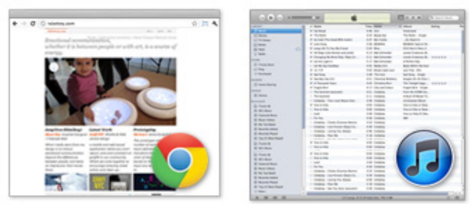
A file stream will replace the static home screen on the computer. Based on a user's contextual information and activities, this stream will be automatically updated. The latest file will be popped in on the top of the stream, and the updates will be made by the user himself, his co-workers through email, and other shared applications and new updates from his other devices. A file unchecked by its user will remain highlighted. This is a notification-driven user interface. If the user wants to change the status of the file as unchecked, he can do so. So later, the highlighted file will capture his attention quickly.

Getting all feeds in one place could overwhelm its user, and contaminate the stream with lots of noise. By digesting redundant files, or a collection of files as one topic, the system can reduce this noise. When the user downloads hundreds of files from his digital camera, this intelligent aggregation feature will compress the photos as a collection.

Arium's stream shows any kind of file—a collection, or bookmarks on the web, for example—so a user can browse all of his activity history on the stream. A music playlist, a website he visits often, and a photo album are all accessible with one click.

A. Notification diriven user interface

B. Intelligence aggregation



C. Media-supported indication

06:20am
CREATE NEW FILE
Microsoft Excel
Microsoft PowerPoint
Microsoft Word
Adobe InDesign CS5.5
Adobe Illustrator CS5.1
Adobe Photoshop CS5.1
Image Capture
TextEdit
TextWrangler
iMovie
iChat
iWeb
Mockup_004.psd
Sarah "Hi Roy, could you have..."
Roy Shin 2 hours ago
Latest: 4.9.2012/ Created: 11.2.2008
Ethics and Robotics
www.ethicsandrobotics.poster....
Shared with Wes Johnson
Saved: 11.2.2008 1:35pm
Thesis_document02.doc
Sarah "Hi Roy, could you have..."
Roy Shin 2 hours ago
Latest: 4.9.2012/ Created: 11.2.2008
Thesis_document_final.pdf
Sarah "Hi Roy, could you have..."
Roy Shin 2 hours ago
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107 songs in iTunes
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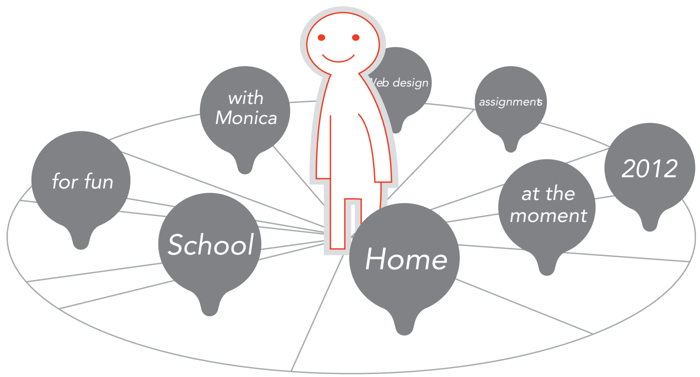
Plays: 184 / Latest: 4 days ago
IMG_0001 ~ 0012.jpg (12)
Roy's iPhone
San Francisco, CA, USA
2.14.2012 - 2. 18. 2012
User research_draft.pdf
Gill "Please make sure if you..."
sent to: Alice Hanry via Gmail
Latest: 4.9.2012/ Created: 11.2.2008
[Web]Class_schedule.doc
x3 Chongho, Wes, Jessica
3.22.2012 3:30pm - send it to Rach
Latest: 3.29.2012/ Created: 1.2.2012
Roy Shin_cover letter02.pdf
Mark Choi : 4.3. 2012
Latest: 3.29.2012/ Created: 11.2.2011
Roy Shin_cover letter.pdf
Mark Choi : 4.2. 2012
Latest: 3.29.2012/ Created: 11.2.2011
[Web]Class_schedule.doc
x3 Chongho, Wes, Jessica
3.22.2012 3:30pm - send it to Rach
Roy Shin_cover letter02.pdf
Mark Choi : 4.3. 2012
Latest: 3.29.2012/ Created: 11.2.2011
Roy Shin_cover letter.pdf
Mark Choi : 4.2. 2012
Latest: 3.29.2012/ Created: 11.2.2011

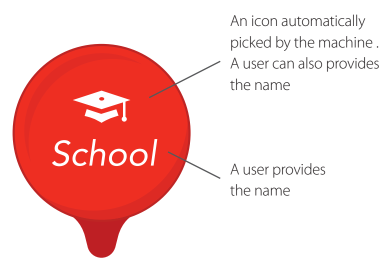
B. Pointee & Pointers, Collectins



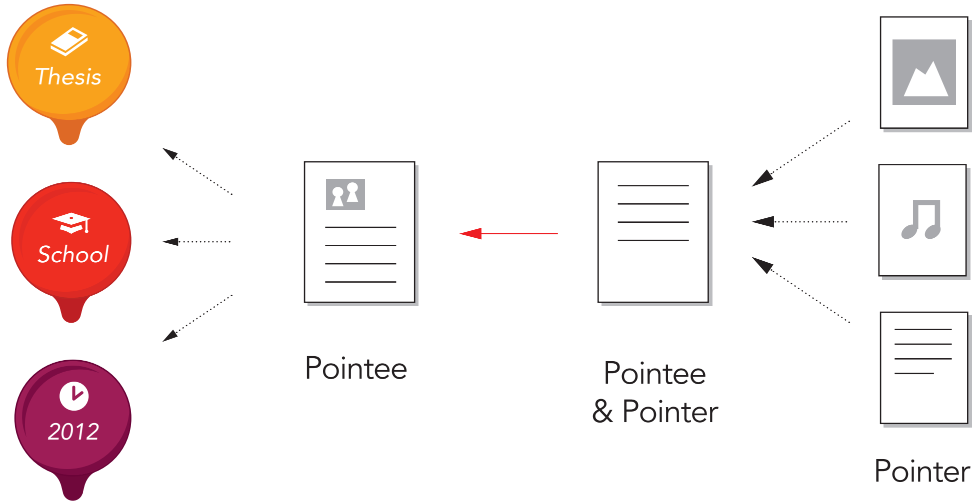
Keeprs represent a user's context

In the data structure I suggested, each file becomes a pointee and a pointer, and any file's relationship to the other files is weighted by the user's contextual information. A group of networked files can be represented as a collection and I named the collection as Keepr.

The strength of Keepr is that the user does not need to worry about the organizing rules. The user's context includes time, location, tasks, and purpose. These contexts can be described with a variety of words such as: "school," "home," "project," "year," or even "for fun at the moment." For instance, my final paper can be pointed to by its resources such as web-site links, images, and quotes from other documents, and it can point to a published PDF file. This final PDF file can be collected by the "School," "Final exam," "important," or "2012" Keeprs.



The Keepr

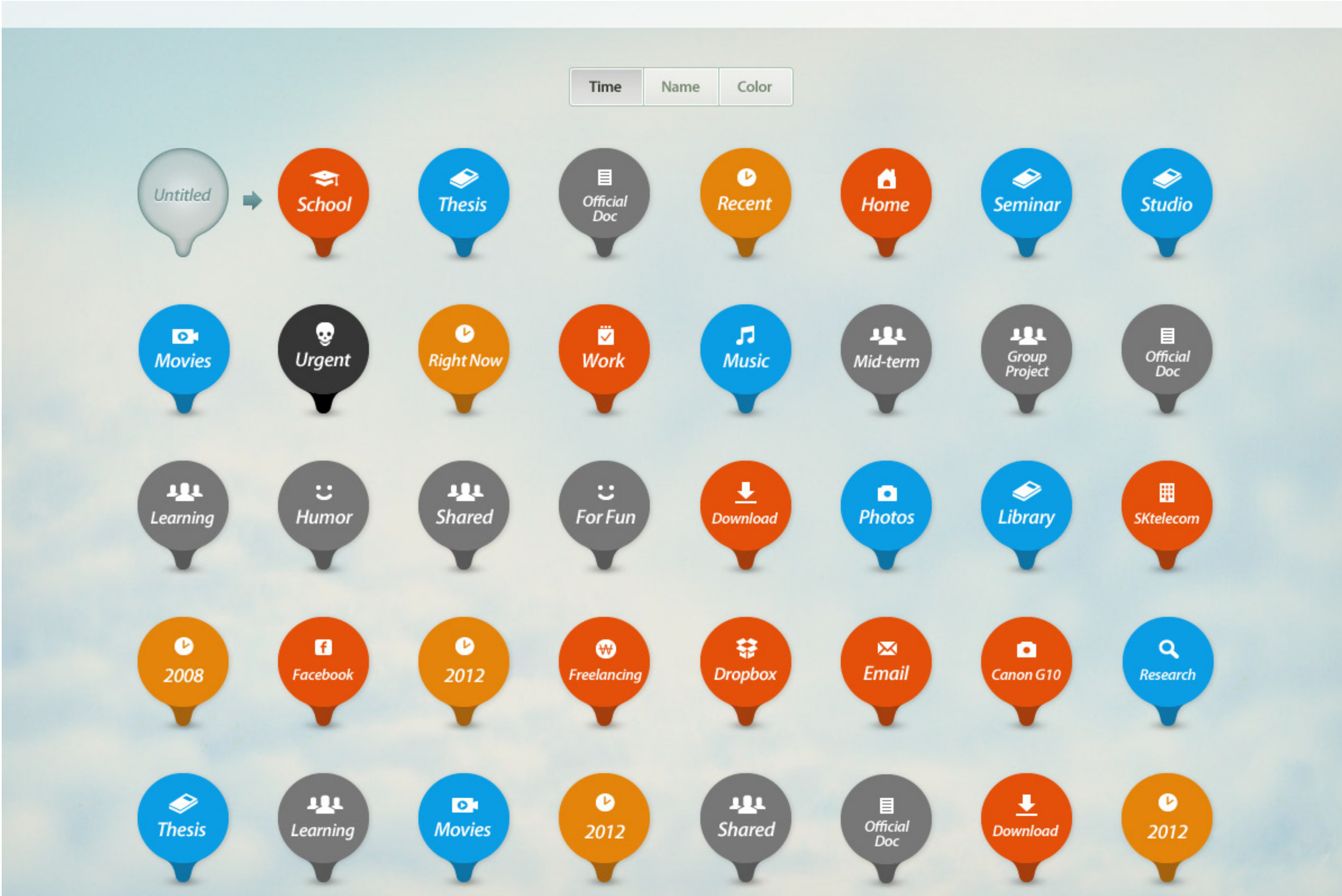


Keepr vs. Tagging

We are are familiar with tagging, and it makes one file more accessible when we need to search by keywords. Even though tagging has a powerful function, only certain groups of online users are using this feature. Why do lots of people fail to tag their digital files? One reason may be that it is arbitrary and has the same problems as those related to our file-naming behaviors.

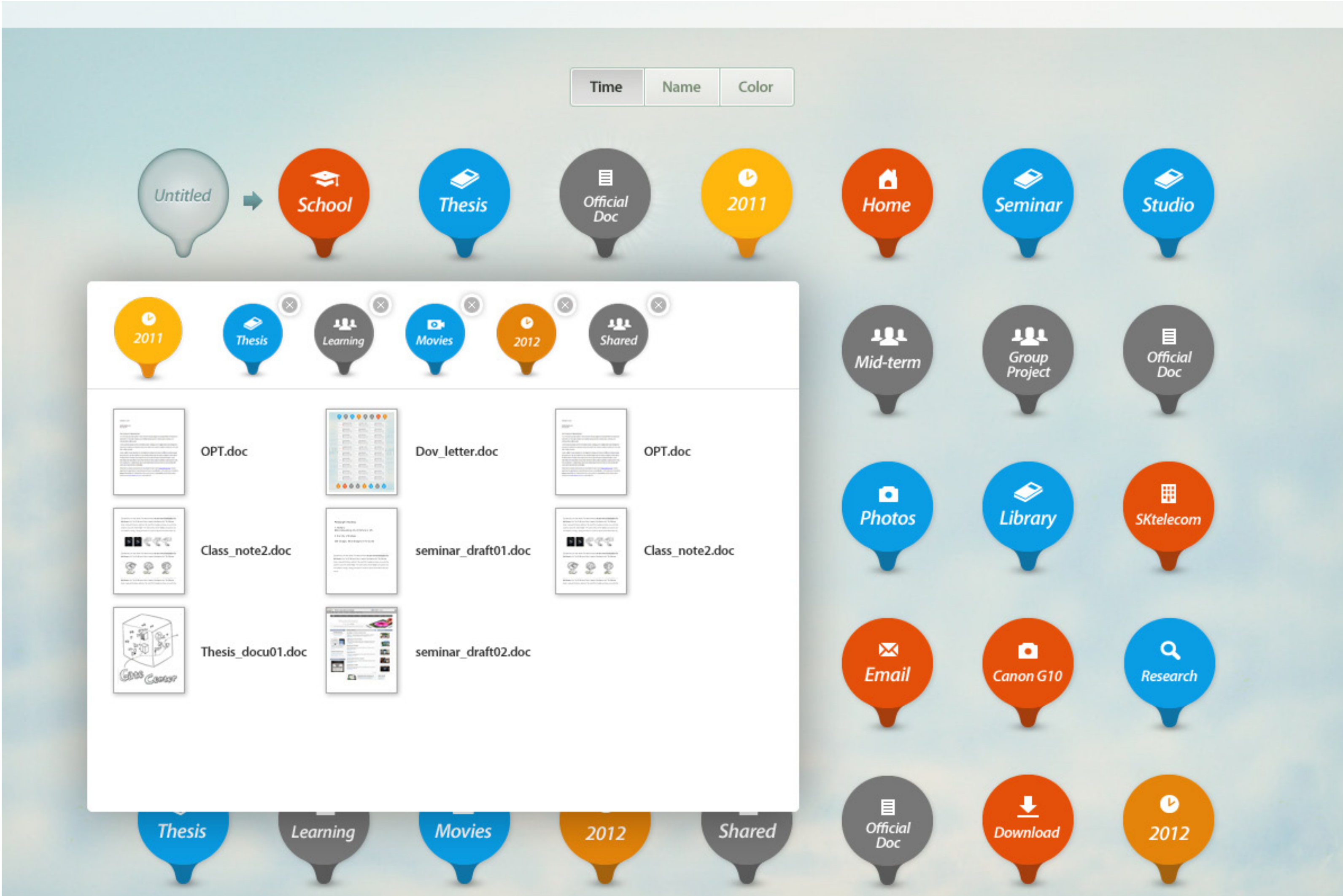
A Keepr still functions as a tag, but it is static. Keeprs are stored in the user's archive, so the user can pick Keeprs—each of which has one keyword—so the user's tags are not arbitrary. If the user doesn't find any words matching with their files, the user can create a new one and store it in their archive.

The archive for Keepr on the home screen



The view of browsing a Keepr 01

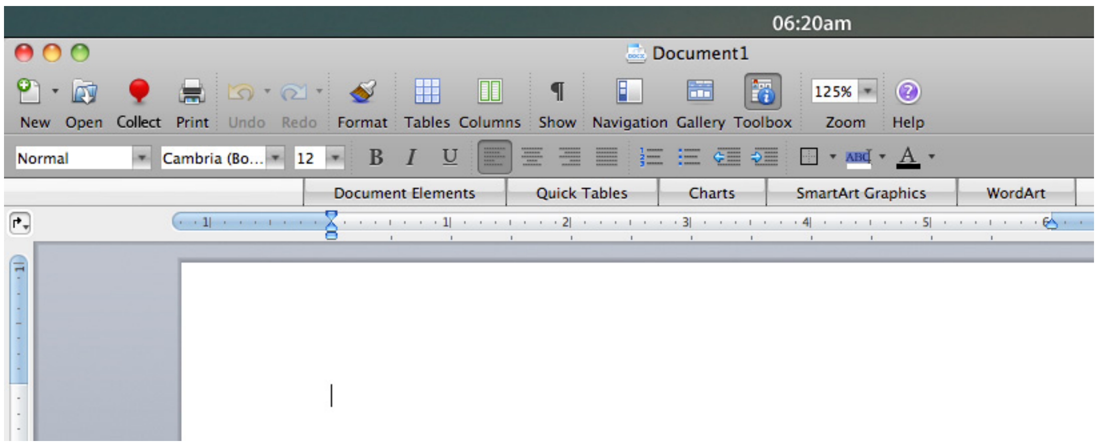
The view of browsing a Keepr 02

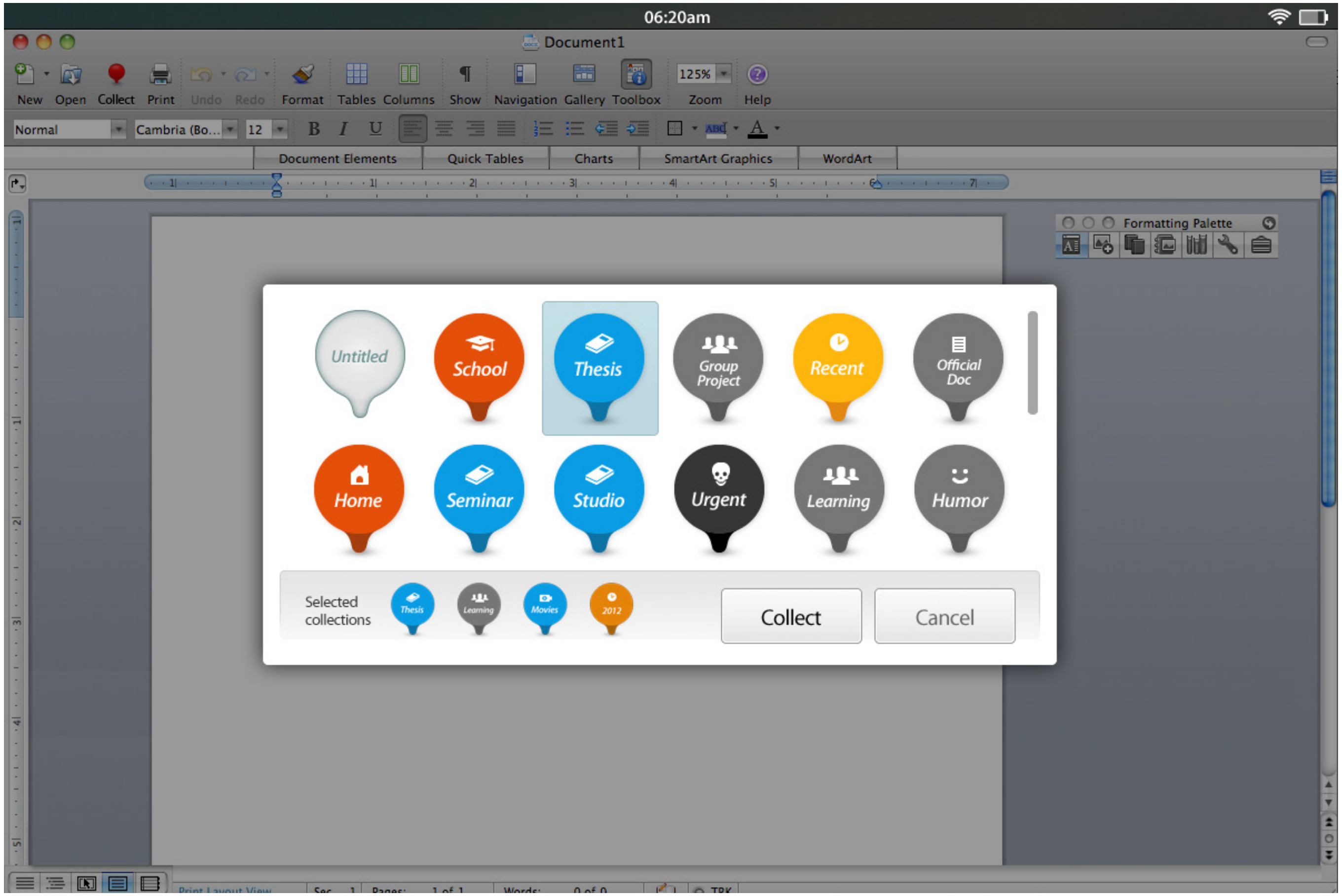


C. Don’t save it, collect it

Our current rules dictate that in order to save a file, we have to place it in a folder, and this folder is then nested inside other folders. This way of organizing our data breaks self-consistency when we save a file. To stick to our original rules, let’s forget about “save.” Instead of saving, tying a file to multiple Keeprs representing our context will help us stay consistent with our organizing rules. Don’t worry, if you don’t tie your file to anything, it will be automatically collected by a master Keepr.

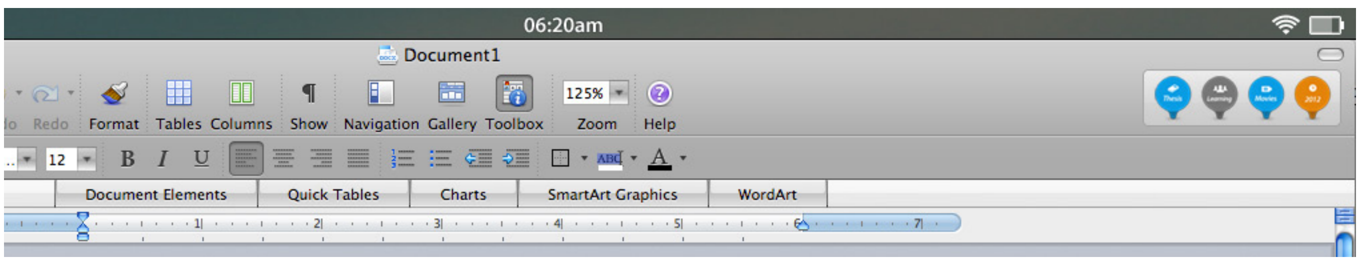
Don’t save, collect





The view of collecting a file

Keepr indicators on a file



Beyond Arium

Reflection & Challenges

During this project, I faced two challenges. First of all, it was challenging to explore a fuzzy area and keep myself from getting lost in the process.Because of the limited resource in this emerging field, I found it difficult to know if I was moving in the right direction. Through this challenge, I learned to choose the best solution considering a vast array of possibilities and consequences in a complex design problem.

The second challenge was finding design's place in this technology-driven field. Designing new ways of organizing digital data and new data structure heavily relies on the advance of technology. The well-developed algorithm of programs could cause significant changes to this project. The invention of Watson, an artificial intelligence computer system capable of answering questions posed in natural languages, discouraged me to continue my thesis as a designer. Watson, developed in IBM's DeepQA project, has the potential to greatly effect daily computing systems in a wide variety of way. This made me think that the capability of designers to influence a product is not as strong as engineers.

This was a good opportunity to consider,as a designer, where I should be positioned in creating new products or system. Engineers can develop the powerful technology that performs intelligent tasks, but designers can create well-designed interfaces between the machine and users. Designers enable users to have meaningful interactions with technology. Therefore, designers need to be the link between users and engineers by understanding both parties well.

During this project, I researched how the computing system technology evolved and user behaviors and preference changed. My research was not focused on how to improve or apply new technology to overcome current limitations of the current desktop metaphor, it was focused on designing meaningful relationships between technology and end users.

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Links

Search

Search is the Web's fun and wicked problem
"Search Patterns" author Peter Morville looks at the next wave of search and reveals the one innovation that led to a watershed moment
http://radar.oreilly.com/2010/02/search-is-the-webs-fun-and-wic.html

Search Patterns Image Collection
http://www.flickr.com/photos/morville/collections/72157603785835882/

"Future of Search" video
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Microformats

Google launches microformat-powered recipe search (Recipe View)
http://microformats.org/2011/02/24/google-launches-microformat-powered-recipe-search

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Google: Google with Recipe view helps you find receipes from across the web
http://www.google.com/landing/recipes/

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http://www.webtrainingwheels.com/2011/02/food-bloggers-google-recipe-view/

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http://www.wired.com/listening_post/2007/03/microformats_go/#previous261d010852926bfa53bcef0a18d4e665

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http://www.wired.com/magazine/2010/02/ff_google_algorithm/

Siri

Why is Siri important? (by Brian Roemmele)
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What do application developers need to know about Siri to interface with it?
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Dropbox

Dropbox is working on ways to move beyond file folders (Talk with Dropbox CEO Drew Houston)
http://techcrunch.com/2011/11/10/dropbox-is-working-on-ways-to-move-beyond-file-folders/

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