CHALLENGES AND TECHNIQUES FOR PERSONAL ENVIRONMENT

MANAGEMENT

A Dissertation

by

ANNA ZACCHI

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

December 2011

Major Subject: Computer Science

Challenges and Techniques for Personal Environment Management

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Approved by:

Chair of Committee,   Frank Shipman
Committee Members,   Richard Furuta
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ABSTRACT

Challenges and Techniques for Personal Environment Management.

(December 2011)

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Chair of Advisory Committee: Dr. Frank Shipman

People today use the computer for many simultaneous work projects and activities. The traditional file system was developed for storing and retrieving files and it and the desktop have not evolved with users' practices. The first part of the dissertation presents a user study that generates a better understanding of the issues and practices regarding the organization of documents in support of activities. The second part provides the design of an environment to organize information based on an activity paradigm as opposed to an archiving paradigm and delivers the instantiation and the evaluation of a system based on such a design. The system, called Docksy, provides an environment structured in workspaces. Each workspace is segmented in areas or panels. Users can use documents as elements to structure their workflow or to manage their activities by separating files in the different panels, and by adding comments, tags, and flags. The Docksy design aims to create a flexible, lightweight environment that is easy to use and can be incorporated into users' daily practice, old or new. Such a system could be used to learn about users' practices and their evolution. Docksy was therefore developed for a double purpose; the short term purpose of testing new features (panels, comments, flags,

and tags) and the long term purpose of facilitating learning about user practices. A study of Docksy use was conducted in which twenty participants used Docksy for at least two weeks and they were then interviewed. The study showed that participants valued the panels and the comment features. The results of the study showed the potential for changing users' practice and the potential for the system to be adopted by users.

DEDICATION

To My Parents

ACKNOWLEDGEMENTS

NOMENCLATURE

CHI   Computer Human Interaction

GUI   Graphical User Interface

HCI   Human Computer Interaction

HTTP   HyperText Transfer Protocol

Mac   Apple Computer

MS   Microsoft Windows

OS   Operating System

PDA   Personal Digital Assistant

PIM   Personal Information Management

Px   Participant Number x

UI   User Interface

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

The computer is the primary working environment for many people today. People perform an increasing number of activities on their computer and at the same time they accumulate an increasing number of documents. Despite this trend the environment that modern desktop environments offer has not changed significantly during the last thirty years. People still organize their documents inside hierarchical folders and/or on the desktop. The traditional file system was developed for storing and retrieving files, but people today use the system mainly as a workspace. They are not only dealing with an increasing number of documents but they are also using the computer for many simultaneous work projects and activities. In short, the support that the system offers has not evolved with users' practices.

The area of research on document organization is vast. Many researchers have studied users' practices regarding document organizations, both in paper and in electronic format [Malone, 1983, Kwasnik, 1989, Barreau and Nardi, 1995, Barreau, 1995, Kaptelinin, 1996, Nardi and Barreau, 1997, Bellotti and Smith, 2000, Ducheneaut and Bellotti, 2001, Whittaker and Hirschberg, 2001, Ravasio et al., 2004, Henderson, 2004, Boardman and Sasse, 2004, Bondarenko and Janssen, 2005, Jones et al., 2005b] and [Kelly, 2006]. New technologies have been developed in support of document

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This dissertation follows the style of *ACM Transactions on Computer-Human Interaction*.

organization, with the goals of facilitating archival and retrieval tasks, of jointly managing documents and emails, of integrating different types of data files, and with several other objectives [Mander et al., 1992, Fertig et al., 1996b, Robertson et al., 1998, Dourish et al., 1999, Dourish et al., 2000, Jones et al., 2001, Peters, 2001, Voida et al., 2002, Bellotti et al., 2003, Dumais et al., 2003, Huynh et al., 2003, Kaptelinin, 2003, Quan et al., 2003, Karger and Quan, 2004, Jones et al., 2005a, Cutrell et al., 2006, Karger and Jones, 2006, Bardram et al., 2006, Moran and Zhai, 2007, Voida et al., 2007, Voida et al., 2008]. Among them one branch of research has been focusing on the management of documents in support of current tasks or activities. The research presented in this dissertation is related to this area.

The purpose of this dissertation was to study the practices surrounding document organization, to design an environment that better supports today's practices, and to implement and evaluate a system based on the new design. This research differentiates itself from others similar in this area for the type of practices studied and for the solutions proposed. User studies in the literature focused on the folder structure or file statistics [Henderson, 2004, Henderson, 2009], on the way users decompose projects in folders [Jones et al., 2005b], or on typical problems people have in creating and using their virtual workspaces [Kaptelinin, 2003]. Similarly to Kaptelinin, this research focused on the practices relative to activities or projects and workspace management, but, besides studying people working on more recent computer systems, it focused on different aspects of the personalization of the workspace; among them the use of the file names and the start menu.

The first part of this dissertation consists of a user study. The goal of the preliminary study was to understand which kind of environments or virtual structures users are trying to build on top of the structures that current computers offer. During the preliminary study, I identified the main computer working environment for each user. I classified users according to four patterns of desktop and file system use. I described the strategies that users employ to customize their environment, and the rationales, if any, for their structures. I analyzed their use of temporary files, the evolution of documents in folders or on the desktop during the life of a project, and the practices regarding file names.

The second part of the dissertation consists of the design and development of a software environment that enriches the current desktop and file systems with features aimed at supporting users in their tasks or projects. The introduction of new tools may fulfill current needs, but at the same time can create new needs; moreover new tools may be used differently than how the designer was expecting. Users appropriate tools or technology at hand [Dourish, 2003], by adopting, adapting and incorporating them into working practices. Practices and tools coevolve. The aim of the design was to create a tool flexible enough to be appropriated by users and incorporated in their daily practice.

The third part of the dissertation describes a user study of Docksy. Docksy is a prototype and a partial implementation of the design. The aim of the study was to have a first evaluation of Docksy and to determine its potential and challenges for changing users' practices. Besides offering document support, it is also meant as a tool to explore adaptation and to better study how people organize their documents.

The next section introduces the problem as the basis of this dissertation. Section 3 presents a literary review. Section 4 describes the theoretical framework. The user study of how people use and adapt their current work environment is described in Section 5. Following the preliminary study is the design and the implementation of the new system, in Section 6. The study of Docksy use is presented in Section 7. Conclusions and future work are in Section 8.

2. PROBLEM

Documents and their organization are part of a bigger work environment. Electronic documents are not just items to be stored and retrieved on the computer. Instead, users view them as explicit components of activities and workflows. Document organizations are used to structure the workspace, to serve as a reminder for future actions, to make sense of topics, to organize the different phases of a project, and to generally improve interaction with the system.

The traditional file system was developed mainly for storing and retrieving files. The desktop made a big step forward in the creation of a work environment. It provides an always accessible space where end-users can spatially organize items, but it does not provide more specific tools to help in the organization of files from a work environment perspective. The file system with the hierarchical folder structure remains basically unchanged.

An alternative to organizing files in a hierarchic file system is to use search, e.g. Windows search or Google Desktop. Search tools have been steadily improving. Initially they could relatively slowly search file names, but are now capable of searching the content and are faster than in the past. But many users still do not rely on search for locating information inside their own computer; or they rely on search only for certain type of files. One reason could be user preference. Another may be that search engines are still not at the level that users require [Fertig et al., 1996a], or because end-users prefer to manually locate their files browsing the folder structure that they created

[Barreau and Nardi, 1995]. There are a number of cognitive rationales for building a file organizational structure and manually locating files. The act of building a structure may help in conceptualizing a problem, in managing resources or in creating a workflow. Browsing through a file structure in which documents organization structures the workflow gives an idea of the status of a project. Also, files found while browsing may jog the memory. Documents may be positioned on purpose to remind users of tasks to do. Tagging systems are an intermediate step between a search and a user organized system. In tagging systems users attach tags to files to facilitate the search. At the same time tagging is a way to classify documents.

Whether access is through the file system or through search, file and application management has not kept up with the use of the computer as the primary workspace. The purpose of this dissertation is to explore ways to support users in managing their personal environment to work on short-term and long-term activities and projects.

3. LITERATURE REVIEW

Before desktop computers came into common use, people were used to working with only paper documents. In an office environment, documents were typically organized on the physical desktop and archived in folder and cabinets, or they were piled on the floor. Despite forecasts of paperless offices [Business Week, 1975], paper documents are still used. Studies [Sellen and Harper, 2003] show that paper in the office has actually increased since the advent of computers. Moreover, since the computer became a common fixture of the office, the number and type of electronic documents that people have to work with has increased. Now people must deal with the double challenge of organizing both their paper and their electronic documents. Various systems that help end-users to deal with the increasing amount of electronic documents have been designed and/or deployed. One assumption, on which the design of many of those systems is based, is that people will transfer their document organization strategies from the paper office to the electronic world. An alternative assumption is that people will develop new strategies in the electronic world. In both cases, user studies are often a first step in the design of new systems.

In this dissertation, I first conducted a user study that analyzed the strategies that people employ in organizing electronic documents while working on tasks or projects. I then developed a system to support those practices. The next subsections present a literature review of user studies relative to document organization and to the solution

proposed. The following section describes the possible theoretical frameworks on which to analyze the evaluation of the system.

The first part of this literature review reports previous studies that explored how users manage paper and electronic documents. Some studies looked at the different type of organizations (e.g., pile vs. file); others highlighted a relationship between people's document organization and type of work. Other studies showed how organization of documents could be an integral part of project management.

The second part of the literature review presents several software tools that were developed to assist people with the organization of their documents, starting from the file system or desktop provided by the operating system, to specific software developed to support users in managing documents or projects. The software review comprises both commercial and research-based solutions.

The third part of the literature review includes a subsection on windows tiling and on spatial organization of documents.

The next section reviews methodologies and theories for conducting studies of practices and for establishing the theoretical background used in this dissertation.

3.1 Studies on Document Organization

A number of previous studies have analyzed how people organize documents, both in paper and in electronic format. Prior research focuses on different aspects of organizations; among them on the organizational strategies, such as pile vs. file, on the classification of documents, such as ephemeral vs. archival, on retrieval strategies, on

relationships among job and type of organization, such as managerial vs. clerical, and on the influence of context. Other strands of research focused on the integration between document management and email management. Relatively little research has analyzed document organization in relation to task accomplishment or project management, and that is the focus of this dissertation.

We can classify past studies on document organization in three areas. The first area includes studies of the organization of documents in paper format. The second area comprises studies of users organizing documents in both formats, paper and electronic. The third area includes studies of user practices with electronic documents.

3.1.1 Paper Documents

One influential research study on paper documents organization is the work by Malone [Malone, 1983]. He conducted a study of how professional and clerical workers organize paper documents in their office. He distinguished between two different organization strategies: files and piles. "Files are units where the elements are explicitly titled and arranged in some systematic order [...]. In piles, on the other hand, the individual elements (papers, folders, etc.) are not necessarily titled, and they are not, in general, arranged in any particular order." He pointed out that the cognitive difficulty of categorizing information is an important factor in explaining why people organize the desk the way they do it. He also wrote that a very important function of the desk organization is to remind users of things to do, not just to help users find desired

information; he suggested that is very important for electronic systems to support this function. His work poses the basis on which much future research builds.

Another influential examination of document management is the research by Whittaker and Hirschberg [Whittaker and Hirschberg, 2001]. They observed paper handling strategies in office workers, and in particular the reasons why people keep documents, and duplication of those documents in private and group collections; they also observed user habits in filing and piling. They noticed that users are both filers and pilers at the same time, but they classified them in one category or the other according to the prevalence of one method over the other. They argued that the reason why office workers file many documents, even when they access them rarely, and even when those documents are duplicated in other collections, is because they invested time and energy in classifying and filing them, and therefore they do not want to discard them. Among their conclusions was that documents of uncertain value possess the most problems to users, because users do not know what to do with them. They report statistics on the accumulation of documents, the way office workers process them and store them, and the occasions when they discard or keep them. The focus of their study is not on how papers are used in the accomplishment of tasks, or on how the environment is set up in order to work on projects, but on the management of the paper archives.

Research into paper document archiving was conducted by Bondarenko and Janssen [Bondarenko and Janssen, 2005]. They observed that document organization strategies change according to the type of activities in which users are engaged. People performing research are often dealing with unstructured tasks, while people performing

administrative activities are more likely to deal with structured tasks. People tend to organize files differently in the two cases. Similarly Malone [Malone, 1983] in his early study suggested a possible relationship between job content and neatness in the paper office. Bondarenko and Janssen [Bondarenko and Janssen, 2005] concluded that digital tools should support "two important user needs related to task management, namely that documents should be embedded within meaningful (task-related) context information, and that they should be easily accessible for regrouping as the task goes on."

The main idea behind much of the paper documents research is that user practices in the physical environment should be supported in the electronic environment. This idea was based on the assumption that practices with the new tool, the computer, will continue to be the same as they were in the previous environment. The same assumption brought to the conceptualization of the desktop metaphor and to the development of the desktop interface. In sub section 3.1.5 I will present a different assumption, based on the concepts of customization and appropriation, in which users adopt a new tool and adapt it to their practices or change their own practices. I based my research and the design of my system on the later assumptions.

3.1.2 Paper and Electronic Documents

The second part of the literature review focuses on studies of people organizing documents in their office and work space, and it includes both paper and electronic documents. One example of research in this area is the one by Kaye et al. [Kaye et al., 2006]. They studied archival practices of academics regarding both paper and electronic

documents. They observed office space, at home and at the workplace, book and paper archives, notes, diaries, calendars, to do-lists, etc. They also had a tour of their computer, including emails, bookmarks, systems for backup, and documents archives. They identified goals for archiving, such as finding it later, building a legacy, sharing, and preserving for fear of loss. They concluded that every archive is personal, that there are not standard best practices, but that every person adopts personal practices based on his own goals, and therefore a digital archive should take these factors into consideration. The focus of their study was on the archiving practices, and on the goals for archiving. The focus of my research is instead on the organizations of documents that are needed during the execution of a task or a project. The starting point for my research is the observation of the practices surrounding document management in support of tasks.

3.1.3 Electronic Document: Archiving

The third part of my literature review focuses on the management of electronic documents, and this is also the area that is the main focus of this dissertation. A fundamental work in this area is represented by the paper of Barreau and Nardi [Barreau and Nardi, 1995]. They studied document organization in electronic systems and they proposed a now widely used classification of files. They classified the type of documents as ephemeral, working, and archival.

- *Ephemeral*: documents that have a short shelf life. An example would be a document waiting for an input from a colleague, or certain emails. Users prefer to keep these in a visible place.

- *Working*: frequently used information relevant to the user's current work. It is usually organized in folders. Users do not typically have problems finding this information.

- *Archived*: shelf life of years, indirectly relevant to current projects. Usually they include completed projects. Users do not put a lot of effort into elaborate schemes for organizing archived information because they perceive it takes more time and effort than what it is worth.

Similar to Malone [Malone, 1983], they also noted that the organization of files is not only used to store and retrieve documents, but also to remind people: "The location of information on the desktop also serves a critical reminding function. Users in both studies across all environments were observed placing files in locations where they were likely to notice them. For example, users left electronic mail messages in the in-box as a reminder of a meeting or placed files in the upper level of a directory structure as a reminder to complete work contained in the files. Macintosh users reported behaviors such as moving icons near the trash can as a reminder to delete them."

According to Barreau and Nardi [Barreau and Nardi, 1995], the documents that are most problematic for users to manage are the ones relative to ephemeral information because of their quantity and because of the fact that they cannot be easily classified into categories. Moreover, Barreau and Nardi found that archived documents are rarely used in an office environment and they do not constitute a problem for users. This finding was reinforced in their follow-up study [Nardi and Barreau, 1997] where they observed that users have a preference for looking for documents by browsing the directory structure they created as opposed to using search. Similar to Malone's finding in the study of

paper documents, they noticed that users place documents in certain positions in a computer system and use browsing practices that involve viewing these positions to be reminded of tasks to do.

In this research, I focus mainly on the type of documents that Barreau and Nardi [Barreau and Nardi, 1995] defined as *ephemeral* or *working*. This classification does not always apply to the results of my preliminary study though. Both ephemeral and working documents are used to structure the working environment, or to define project spaces. Different documents may have a different position or relevance inside a project space, but their classification is related more to their belonging to a project or its related workflow. A document waiting on input from a colleague, for example, has some temporal characteristics that put it into the ephemeral class, but at the same time it belongs to a project or to a task, and as such it belongs to the workflow for that project or task. The preliminary study, presented in the next section, also analyzes temporary documents, and proposes a classification for them. One of my proposed classes of temporary documents, *to throw*, does not belong to any of the classes defined by Barreau and Nardi. In their paper they also said that users typically archive working documents into a folder and that users do not have problems in finding them. While finding documents relative to a current project may not be a problem, structuring the project space to make it easier to work on a project is one of the goals of this research.

Additional studies of electronic document management are focused on different approaches to organization that are based on document type or document characteristics. Boardman and Sasse [Boardman and Sasse, 2004] tracked personal information handling

across different types of data: files, email, and bookmarks, and across time, taking snapshots of the folder structure for seven to ten months. They found that users employed different strategies in archiving the different kind of data and that the perceived value of information influences the selection of Personal Information Management (PIM) strategies. The study by Bondarenko and Janssen [Bondarenko and Janssen, 2005] analyzed the extensiveness of the folder structure and the level of effort necessary to keep it organized. By file organization they meant that users file a document in a folder as opposed to leave it in a temporary space. Another study with a somewhat similar focus, is presented by Ravasio et al. [Ravasio et al., 2004]. They detailed daily practices of document classification and retrieval. They analyzed the average age of archival documents, the number of files in folder, details of the hierarchical structures, etc.

Fertig et at. [Fertig et al., 1996b, Freeman and Gelernter, 1996, Gelernter, 1992] used time to organize documents. Their software, LifeStream, is based on a time-ordered stream of documents that replace directories. A stream presents document in the present, and via scrolling it is possible to locate past and future documents. Placing documents in the future is equivalent to place reminders. Many other researchers have conducted related studies [Barreau, 1995, Czerwinski et al., 2006, Ducheneaut and Bellotti, 2001, Fertig et al., 1996b, Henderson, 2004, Henderson, 2009, Huynh et al., 2003, Jones et al., 2001, Jones et al., 2002, Jones and Dumais, 1986, Kaptelinin, 1995, Kwasnik, 1989, Mander et al., 1992, Marshall and Jones, 2006, Marshall and Bly, 2005, Moran and Zhai, 2007, Peters, 2001, Ravasio et al., 2004, Voida et al., 2007, Voida et al., 2002].

While my study deals with electronic document organization, the focus of my research is different from the research presented in the papers above. While the above research focuses more on archival practices, the focus of my study is on documents that are currently in use and for which the time to archive has not yet arrived. It also includes those cases in which participants manage current working documents by placing them into an archive.

3.1.4 Document Organization and Project Management

Much of the above research indicates that how people organize information is heavily influenced by their current activities. There are a few studies of document organization in computer systems aimed at understanding their relation to task accomplishment or project management [Bardram et al., 2006, Bellotti and Smith, 2000, Dourish et al., 2000, Dourish et al., 1999, Henderson and Card, 1986, Jones et al., 2005a, Jones et al., 2005b, Kaptelinin, 1996, Voida and Mynatt, 2009, Kaptelinin, 2003, Voida et al., 2008].

Among those is the work of Jones et al. [Jones et al., 2005b]. They explored the way people organize information in support of projects. They wrote that folders frequently reflect basic problem decomposition, or a plan for project completion. For example, a wedding project may be decomposed in Invitation, Honeymoon, Cake, and so on, and each part is assigned to a distinct folder. In this case folders are a tool to organize a project.

In 1996, Kaptelinin [Kaptelinin, 1996] published a study whose focus is similar to the focus of the preliminary study of this dissertation. The objective of his study was

"to determine if there are some typical problems people have in creating and using their virtual workspaces, as well as integrating them into their work environments at large, and what kind of computer support can be provided to the users to help them solve these problems." By virtual workspace, he meant the space built by configuring resources necessary to work on a current project, by making frequently used files easily accessible, and so forth. He studied the strategies people use in customizing their workspace and the typical problems people encounter in creating and using their virtual workspace. He used Activity Theory as the basic approach to understand the relationships between human beings and their environment. Among his findings is that each user creates his own view of the file system by placing items on the desktop or on the hard disk. The study was in 1996, all users were using Apple Macintosh, and they were still making heavy use of floppy disks. Some of the problems encountered in that study were relative to features of the system not available at that time, or to problems overcome with new versions of the operating system. But his findings bear witness to users' attempts to create a working space in a system that does not actively support it, and this is still true today: "The means for creating task/project environments provided for the users by the Macintosh System 7—the Desktop, aliases, and the LABEL menu -- do not seem to be very helpful." Those problems are still current today as my preliminary study shows. My study differs from Kaptelinin's in that, while it has the same focus, it looks at different aspects of the personalization of the workspace, including the use of the file names and start menu. Moreover the focus is not so much in highlighting the problems, but in understanding the practices. My study also concerns to more current computer systems.

During the last ten years, the increase of computer use and the evolution of both their hardware and software have changed many practices.

3.1.5 Information Management and Work Practices

An influential study on document organization and activities is the study of Dourish [Dourish, 2003]. He explored the relationship between documents and activities and in particular between document organization and activity workflow. Dourish's goal was to expand the study of document organization by including work context and work practices. The process of document organization is part of the more general process of customizing the environment and preparing it to execute the work at hand. He distinguishes between customization and appropriation:

Customization: specialization of a tool to the needs of particular users or settings.

Appropriation: the way in which technologies are adopted, adapted and incorporated into working practices.

One of Dourish's goals was to understand which features of technology support appropriation. One of his conclusions was that many information systems are based on hierarchy, which is a restrictive paradigm. As a result, users have to invent a range of creative approaches in order to manage their information within this constraint. Users appropriate the system by creating personal information structures and procedures for managing them.

Dourish's paper is influential not only for the study per se, but for shift in perspective that he introduces, for the focus on the process of appropriation. The perspective that he introduced is used as the approach in this dissertation.

3.2 Document Management Solutions

Different software solutions for the management of documents have been proposed. The following subsections present different approaches to the management of documents or data on a personal computer. Each approach presents systems that have a particular goal in mind, such as the goal of managing documents without using hierarchical representations, or the goal of integrating different data types, or the goal to support unstructured information, and finally the goal to support project-oriented document management.

3.2.1 Non-Hierarchical File Structures

The file system uses a hierarchical structure, or a tree structure, based on folder and subfolders or directories. "In fact, almost all information systems are based on a single information structure – the hierarchy. Hierarchies pervade information systems of all sorts, from the file system (perhaps the most widespread information management device used on conventional computer systems) to email systems, contact managers, and Web browser bookmarks. Users are forced to find ways to map their information needs onto this single structure. A variety of studies have shown the problems that users face in

in trying to perform a wide range of information tasks with this simple structure"
[Dourish, 2003].

Alternative structures not based on hierarchies have been proposed. Dourish et al.
[Dourish et al., 1999] developed Presto. Presto is a prototype document management
system that provides interaction with documents through user-level document attributes,
such as "Word file," "published paper," "shared with Jim," "about Presto," or "currently
in progress." The different roles that a document might play are captured in these
document attributes, or labels. These attributes allow users to access their document
space based on the characteristics important to their task at hand.

Huynh et al. [Huynh et al., 2003, Quan et al., 2003] also worked on the
possibility to classify documents not in a hierarchical structure but in a structure based
on multiple attributes. They noted for example that path names often consist of a series
of attributes. For example, the path "recipe/dessert/Italian" contains three attributes: the
files in the folder are recipes, they are Italian, and they are desserts. The attributes do not
need to be specified in the same order in order to reach a folder. Their platform,
Haystack, achieves this possibility; each file is reachable using folders and subfolders
that are a permutation of the different attributes.

The use of this type of classification, with multiple attributes whose order is not
important, is becoming common in systems such as Google email. In such systems email
are categorized with the use of tags. Users assign multiple tags to individual documents
and then retrieve documents by searching for those tags, or visualizing groups of
documents having the same tag.

The software system proposed in this dissertation also proposes a structure that limits the use of hierarchical folders, but mainly through the use of a visual representation.

3.2.2 Integration of Different Data Types

Some applications manage their own data files. This is the case of emails readers and iTunes and similar programs for audio or video files. This is seen as a restriction when those emails or multimedia files are part of other groups of files or projects and users would like to store them together with the project. Below are examples of applications developed with the goal of unbundling the data from the applications that manages them. The motive that underlies these efforts is the realization that users try to arrange documents by projects or according to their work.

One of the goals of the Haystack application, described by Karger et al. [Karger and Jones, 2006, Karger and Quan, 2004], is the unification of different kinds of information, such as files and emails, in a single structure by integrating multiple data sources. Haystack assembles information from different applications into a single view. Haystack aims at being a system on which to experiment and study usability issues related to tasks and file management across multiple data domains.

A different system to manage multiple types of information was developed by Dumais et al. [Dumais et al., 2003] and called SIS (Stuff I've Seen). SIS provides a search interface and at the same time it is a tool to integrate different data that has been previously viewed. The system creates a unified index of information that a person has

seen on their computer, whether the information was an email, web page, document, media file, calendar appointment, etc. Moreover, it adds contextual cues such as time, author, thumbnails and previews. SIS is a search interface, not strictly a tool to manage documents, but it helps in creating a context for each document and that context may be loosely related to a task or project.

The integration of resources of different data types answers the need to group together different kinds of items that belong to the same project. In this dissertation I propose a different approach to group project items.

3.2.3 Unstructured Information

Barreau and Nardi [Barreau and Nardi, 1995] noted that ephemeral documents posed the greatest challenge to managing documents because those cannot be easily classified in categories. Ephemeral documents are documents that have short shelf life. At the same time Bondarenko and Janseen [Bondarenko and Janssen, 2005] observed that people performing research activities are dealing with unstructured tasks. In this case documents do not have a classification from the beginning; they are in a limbo regarding their possible belonging to a group of files or folders.

The preliminary study described in the next section presents a classification for documents in unstructured tasks that the user considers temporal, and the classification differs from Barreau and Nardi's characterization of ephemeral files.

Shipman and Marshall [Shipman and Marshall, 1999] argue that forcing users to formalize their work while they are still in the creative phase may hinder its articulation.

They argue that systems should incrementally support user formalization without forcing them to do premature commitments or to make structures explicit. They propose the use of spatial hypertexts [Marshall and Shipman III, 1995] to incrementally support formalization. The reported studies of spatial hypertext assessed the value of using visual cues and layout for structuring information in a workspace. In these studies, information in the workspace varied from being chunks of text and pictures to documents and files. One spatial hypertext tool is VKB (Visual Knowledge Builder) [Shipman et al., 2001]. VKB automatically identifies structures in the spatial layout and presents these to the users by visually showing groupings of the objects in the space.

The system I propose in this dissertation also offers visual support for the organization of documents in unstructured tasks without forcing the user to commit and at the same time providing a way to incrementally structure the organization.

3.2.4 Tools and Environments for Supporting Projects

The connection between activities and resource management has motivated the development of tools for supporting projects. ROOMS [Henderson and Card, 1986] was an early tool to manage windows. The purpose was to provide as much space as possible for people to work. The authors analyzed the statistics relative to windows usage and reference. They found that users work with a group of windows for a while, and then switch to work on another set of windows. Henderson and Card used this principle of locality to design the ROOMS system. Windows belonging to a set of locally referred

windows belong to a project or type of task. Therefore each ROOM is an area containing items relative to a project or task.

The Universal Labeler (UL) [Jones et al., 2005a] is a tool that unites different types of information in a common structure. A Microsoft WinWord type outline forms the basic structure of a project that users fill with different items. Labels represent projects, subprojects or tasks. The goal of UL is to integrate different types of information and to integrate information and project management.

UMEA [Kaptelinin, 2003] is a prototype developed to support the project work context, that is, to organize necessary resources to make them readily available when working on the project. UMEA collects interaction histories that it uses to add items to a project space.

In task management, email plays a central role. Bellotti et al. [Bellotti et al., 2003] propose to use email as the center for organizing personal information. To this end, they developed a system called Taskmaster that embeds task-centric resources directly in the email client.

The system proposed by Voida et al. [Voida et al., 2008] aims at changing the desktop from a location where users store files to a place where users store activities. They proposed a system called Giornata in which users explicitly define activities. Giornata proposes a virtual desktop for each activity. Each virtual desktop acts both as a desktop and as a folder for the files related to the activity. Each activity can be tagged.

The ideas behind the design of Giornata are very similar to the ideas behind the design of the system proposed in this dissertation. My system approaches the issues of

integrating documents with task management differently, by providing the user with lightweight visual structures that build on top of the file system, and by providing a means for the user to explicitly use the documents themselves to structure the work flow.

3.3 Spatial Arrangements

The system proposed in this dissertation provides two types of spatial arrangement. The first type is the segmentation of the working space in rectangular areas that covers completely the working space. The second is spatial arrangement of objects inside an area. The next two sub subsections cover some of the literature relative to tiling layout and an approach to spatial arrangement based on spatial hypertexts.

3.3.1 Tiling Layout

The first type of arrangement consists in tiling the space with objects. One common approach used in many windows systems consists in windows tiling.

Tiled windows systems were first introduced by Xerox [Johnson et al., 1989, Gifford et al., 1988] and Andrew WM [Gosling and Rosenthal, 1984]. Xerox Star, CEDER, and Andrew WM tiled applications' windows. The first Microsoft Windows 1.0 [*Microsoft windows user's guide, version 1.0*, 1985] and Digital Research windowing system GEM 2.0 [Reimer, 2005] used exclusively a tiling system. Siemens created the windows manager RTL[Cohen et al., 1988] and deployed it on SINIX, Siemens' system. RTL featured algorithms of automated window scaling, iconification, placement and arrangement. Microsoft introduced the first windows manager with Windows 95

[Sullivan, 1996]. It offered both a stacking approach and a window tiling that allow users to choose between horizontal and vertical tiling. In windows tiling, the windows can belong either to open applications or folders. Algorithms calculate the dimensions and location of all the currently open windows.

This dissertation uses panels that tile the working space. The panels developed for this dissertation are managed differently from the application windows in traditional tiling system. In traditional tiling systems the user decides which applications to open and the windows manager algorithm calculate the size and position of the relative windows. If the user opens a new application or closes an open one, the window manager recalculates the position and size of all windows and rearranges them. In this dissertation tiling is a way to segment the space, not to maximize and place all the open windows. The space is divided in areas, using a column or a matrix scheme. The user cannot open or close windows. The user decides the number of rows and columns, and their height or widths. There is not an algorithm that calculates sizes and positions based on the number of open windows. The system developed for this dissertation does not use application windows, but panels that contain documents.

Table 1 compares different features of windows or panels systems that contain documents or other objects. It compares Docksy, the system developed for this dissertation, Windows traditional folders, TinderBox's Adornment [Bernstein, 2003], and VKB collections[Shipman III et al., 2001]. Containment means that the feature contains the object; it is not only a visual feature or background. Multilevel means that

the feature can contains other features of the same type, such as a folder can contain other folders.

Table 1. Comparison of various containment systems.

	Hierarchical	Containment	Multilevel	Tiling
Docksy Panels	no	yes	no	mandatory
Folders	yes	yes	yes	optional
TinderBox Adornment	no	optional	no	no
VKB Collection	Yes	yes	yes	no

3.3.2 Spatial Hypertexts

NLS [Engelbart, 1962] was the first system to organize documents using a hypertext. Documents can also be managed by organizing them into spatial hypertexts. Spatial Hypertexts are a result of the move from document-centered hypertext systems to map based hypertext systems, a change in perspective from the links among texts to the organization of the documents themselves [Shipman III and Marshall, 1999]. Spatial hypertext systems, like VKB [Shipman III et al., 2001], support the user in organizing small nodes of text or links to documents and web pages.

Spatial hypertexts could be used to organize personal collections of files in a workspace environment. By using VKB for example it is possible to organize in a spatial hypertexts links or shortcuts to documents. The idea of spatial hypertext can be expanded [Zacchi, 2004] to propose an interface to the file system that uses a spatial

hypertext to organize the documents of a file system and the text that creates a context for the files. In some respect this idea puts together the concepts of a spatial hypertext, a web page and a file system.

4. THEORETICAL FRAMEWORK AND APPROACH

Every scientific discipline relies on a set of methodologies, evaluation methods, and scientific theories. This dissertation proposes a study of how people use a currently available computer system, the development of new features to complement the current system, and an evaluation of the resulting system, including observations of how people change the current practices with the introduction of the new tool. It is therefore important to choose an appropriate methodology to conduct the study, to evaluate the results, and to choose criteria for the design and development of the tool. This section introduces a theoretical background for such activities.

The field of Human Computer Interaction (HCI) has evolved greatly in its relatively short history. Since its beginnings in the middle of the 1950s, several disciplines have engaged in HCI research and application development; HCI attracted researchers from fields as diverse as human factors, ergonomics, computer science, information science, cognitive science, psychology, sociology, anthropology, industrial engineering, art, design and so on. During the evolution, as some technologies and practices became widespread, they often induced the formation of new disciplines and the modification of existing ones.

Several authors have written histories of HCI trying to identify trends. Grudin [Grudin, 2011] identified four different fields with major HCI research threads: 1- Human Factors and Ergonomics, 2- Information Systems (managerial use), 3- Computer Science and Computer-Human Interaction, and 4- Information Fields (specialist use; it

includes library sciences and digital libraries). Another widely read history of HCI is the introductory chapter of *Readings in Human Computer Interaction: toward the year 2000* [Baecker, 1995]. In a later version of the chapter [Baecker, 2008] Baecker reviews significant early themes: hypertext, interactive graphical interface and direct manipulation, Graphical User Interface (GUI), graphic design, usability testing, and studies of workplace context.

4.1 History of HCI Theories

A history of the theories or scientific aspects of HCI is likewise complex. At the beginning of HCI there was no theoretical framework: "In origin, human factors is an a-theoretic and pragmatic approach to identifying problems in industrial systems and ergonomics" [Harrison et al., 2007]. Later HCI began to incorporate many diverse theories from various disciplines.

An analysis of the evolution of HCI and its theories gives rise to different interpretations. Here I examine two different interpretations: the first from Carroll [Carroll, 2009] and the second from Harrison et al. [Harrison et al., 2007]. In both papers the authors identify similar historical periods, but they differ in their interpretation of how the evolution happened. For Carroll, practice and theories coevolved and influenced each other: "One of the most significant achievements of HCI is its evolving model of the integration of science and practice." [Carroll, 2009]. For Harrison et at. [Harrison et al., 2007] the evolution of the theories in HCI follows a model of scientific paradigms

shifts, where paradigms are inspired by the definition of Kuhn [Kuhn, 1962], later reformulated by Agre [Agre, 1997].

In his influential book, *The Structure of Scientific Revolutions* [Kuhn, 1962], Kuhn argued that science does not progress via a linear accumulation of new knowledge, but undergoes periodic revolutions, also called paradigm shifts. While science is productive in one paradigm, there are always results that do not fit with the main theories. When the number of these anomalies increases, a crisis point is reached, and a new paradigm enters the scene. The new paradigm will make sense of the old results together with the anomalies. During the transition from one paradigm to another the nature of scientific inquiry within one field is greatly changed.

In order to follow HCI paradigm shifts, Harrison et al. [Harrison et al., 2007] find more appropriate to follow Agre's ideas of generative metaphors [Agre, 1997] instead of Kuhn's scientific theories [Kuhn, 1962], since HCI has an interdisciplinary breath, and it is more difficult to identify scientific theories. In HCI, metaphors are more appropriate to identify paradigms than theories. Metaphors have a significant role in organizing scientific research programs. Metaphors establish mapping between two different discourse domains, such as between a computer interface and a desktop or office environment. A metaphor is generative when a research community can extend its own discourse by carrying ideas from one domain to the other.

The next two sub subsections will present a synthesis of the two interpretations of the evolution of HCI theories. The portion of particular relevance for this dissertation

is the transition between the second and the third eras or paradigms, and the different goals and methodology required to carry out research in the third paradigm.

4.1.1 Carroll and the Integration of Science and Practice

Carroll [Carroll, 2009] identifies three different eras in the evolution of HCI. Initially it was synergy between cognitive engineering and cognitive science. During this period HCI was developing user modeling, or working on direct manipulation, or on user interfaces. In the second period HCI assimilated ideas from social-cultural sciences and more advanced cognitive science, such as activity theory, distributed cognition, and ethnomethodology. During this period collaborative interaction became one important topic. Lab studies diminished in their importance in favor of field or ethnographic studies. In the third period design became the center of attention. For the author, the evolution of HCI occurred as a synergy between science and practice.

"One of the most significant achievements of HCI is its evolving model of the integration of science and practice. […] Conceptions of how underlying science informs and is informed by the worlds of practice and activity have evolved continually in HCI since its inception. In each of the three eras of HCI, […] paradigm-changing scientific and epistemological revisions were deliberately embraced by a field that was, by any measure, succeeding intellectually and practically. The result has been an increasingly fragmented and complex field that has continued to succeed even more. This example contradicts the Kuhnian view of how intellectual projects develop through paradigms that are eventually overthrown." [Carroll, 2009]

4.1.2 Harrison et al. and the Three Paradigms

Harrison et al. [Harrison et al., 2007] find that is useful to see the evolution of HCI in terms of three paradigms. Central to each paradigm is a generative metaphor [Agre, 1997] that guides questions and methods appropriate for that paradigm. Each of the three paradigms encompasses several frameworks: the third paradigm for example includes the ethnographic investigations framework and the Activity theory investigation framework.

The first paradigm is human factors, rooted in engineering practices. In this paradigm the central metaphor is the one of man-machine coupling. The goal is to optimize the fit between humans and machines. There is not an underling theory, but a pragmatic approach to solving problems that researchers were identifying in industrial systems and ergonomics.

The second paradigm is classical cognitivism or information processing. In this paradigm the dominant metaphors is the one of mind as an information processor coupled with the machine. The aim is to facilitate the communication between the man and the computer. Central to this paradigm are the development of models and the comparisons of models against tasks.

The third paradigm includes research approaches developed in the last 25 years that do not fit well with the previous two paradigms. The authors call this third paradigm phenomenologically situated: "The goal for interaction is to support situated action and meaning making in specific contexts, and the questions that arise revolve around how to complement formalized, computational representations and actions with the rich,

complex, and messy situations at hand around them." There are strands of research that need metaphors alternative to the information processing metaphor that is at the center of the second paradigm, the cognitive paradigm. Among them are research in which the context plays a crucial role, such as in mobile computing, research that focuses on socially situated interaction, research that focuses on not-task-oriented computing (e.g. ambient computing), and research on emotions.

In the third paradigm, design has a central role; design is an element of enquiry. Since interaction is seen as an element of situated action in the world, the understanding or construction of the situation is the core of the design. Design is constructed to pose intellectual questions, the questions that are at the base of the analytical frame, instead of using design to find an answer to problems and hypotheses.

4.1.3 Design as Element of Inquiry

The two different views of the evolution of HCI theories concord in the identification of the main three paradigms or eras and disagree on how the evolution occurred. Both positions agree in that the current era or paradigm design has an important role, and that human activities are situated, or culturally embedded.

This dissertation places itself in the third paradigm and agrees with the view that design is an element of inquiry, and that the goal of interaction is to support situated action: interaction is seen not as a form of information processing but as a form of meaning making.

How is research conducted in this third paradigm? What are the methodologies? Which theories can be used? The following subsection will describe why this research is placed in the third paradigm and they will present some examples of research conducted in this paradigm.

4.2 Why the Third Paradigm?

Why does this research belong to the third paradigm? The main goal of this research is to study how people organize information while working on a project or on tasks, and to provide tools to better support it. There are several reasons why research methodologies like the ones used in the second paradigm are not appropriate for this research.

The environments provided by current systems, such as the directory structure and desktop, are very generic, and people adopt a variety of different strategies to organize and manage their documents. When new tools or technologies are introduced, people appropriate them, and use them often in ways different from what the designer envisioned. At the same time, technology changes people, it changes their habits, and also their cognitive capabilities [Dourish, 2003].

In this context, the conceptual development of a model of the user, or a cognitive model, typical of the second paradigm, is not appropriate. Users of a desktop, a file system, or related tools are provided with an environment with relatively few constraints and each user builds his own strategies or practices to organize the documents. It is important to understand which kind of structures the users use to conceive the structures of the system, and it is interesting to explore which structures the users build with what

they have available. But it is not feasible to build a single model of the user, since each user has a different model. Models in general are used to forecast user behavior, using previous behavior as a predictive indication, but the goal of this research is to understand behavior in the first place.

An additional important point is the role of the preliminary studies and their relationship to design. While the second paradigm uses preliminary studies as a step to elicit requirements, I agree with Dourish and Button [Dourish and Button, 1998] in the view that certain type of studies, such as ethnographic studies, should not be used to elicit requirements, but their thick description should be used to inform design.

Task oriented activities, carried on in lab studies, are great tools that research in the second paradigm employs to compare the efficacy of one tool versus another. The purpose of this research though, is to create a tool to study how people change their practices, and how they appropriate the tool. While it will be interesting to compare this tool against specific tasks, it is more interesting to see how people structure their tasks when using this tool.

Another important reason why this research does not fit the second paradigm is that the tools or the system developed are not the final goal. The final goal is to learn about people's practices regarding document organization and the way they change with a new tool. The evaluation of the tool is not the main goal. The tool is a means to find out about people and document organization. During the preliminary study, I observed strategies employed by people. In some cases we assumed that end-users employed a specific strategy to overcome a deficiency in the system. If I add features to the system

to overcome the deficiency, will end-users use the new features to overcome the deficiency we observed? Was the original deficiency actually the reason why end-users devised a particular strategy?

The third paradigm is open to exploratory research. Exploratory research is used to generate hypotheses that will be refined or tested later. The addition or modification of features to the system allows research where hypotheses are generated not a priori, but following the analysis of data, and new hypotheses are generated dynamically with the changing of the system characteristics and the validation or refinement of previous hypotheses. This is the kind of research I am interested in conducting in this dissertation.

For all these reasons, this research better fits the third paradigm.

5. PRELIMINARY STUDY*

In the summer of 2006, I conducted a study to observe how end-users use documents on their desktop or in their folders structure to organize their own activities and tasks. The results of the study, published in Zacchi and Shipman [Zacchi and Shipman, 2007], informed the design of the system implemented for this research.

The study focused in particular on the use of documents in current activities, as opposed to archived documents. I classified end-users in four different groups, according to how they were using the desktop. I looked at the practices surrounding file naming, the use of temporary space, and the customization of spaces dedicated to projects.

5.1 Research Questions

A number of previous studies found in the literature have analyzed how people organize documents, both in paper and in electronic format. Prior research focuses on various aspects of organizations; among them on the organizational strategies, such as pile vs. file, on the classification of documents, such as ephemeral vs. archival, on retrieval strategies, on relationships among job and type of organization, such as managerial vs. clerical, and on the influence of context. The focus of this preliminary study was organization of documents in relation to task accomplishment or project management.

The research questions for the preliminary study were the following:

- How do users integrate document management with their particular tasks?

- Which kind of organization do users use?

- Why did users choose a particular way to organize files?

In order to answer these questions I conducted a study during which I observed participants' file organizations and asked users questions about such organizations.

5.2 Study Setting

Thirty faculty, students, and staff at Texas A&M University participated in the study (see Table 2). The study consisted of semi-structured interviews concerning computer use and observations of strategies for organizing documents and other resources. Each study session lasted between twenty minutes and one hour. The participants were all older than 18 and 50% of them were older than 35. Students, faculty, and researchers belonged to different academic areas, both scientific and humanistic. Everyone had used a computer for more than three years, with 87% of the participants for more than 10 years. They were using a variety of operating systems: four participants used Mac OSX, three Linux and 14 Windows XP.

Table 2. Preliminary study: number of participants for each category

Master Students	Ph.D. student	Faculty	Staff	Researchers
3	11	11	3	2

During the interviews, I did not pose the research questions directly to participants, but I asked a series of questions that would lead me to an answer for the above questions. I started the interview by enquiring which kind of work the person did. Other common questions I asked during the interview were:

- Which kind of activities do you do on your computer?

- Where do you keep most of your documents?

- Which kind of files do you keep on the desktop?

- Is there a special organization for files and why?

- How do you access your documents?

- How do you arrange documents relative to one project?

- Where do you write notes?

- How would you like to organize your documents differently?

The interview then proceeded based on the answers to previous questions and based on observations of participant's organization scheme.

Information about how participants put together various elements to create their own personal work environment was gathered and synthesized. All the interviews were video recorded and transcribed. The focus of the study was on documents and workspace organization, and in particular I analyzed how participants' broader system use created project spaces. This broader context included the use of shortcuts, the desktop, the taskbar, the start menu, and the role of applications (e.g. MS WinWord® or MathLab®) in project organization.

The results of the study are presented in the next subsections. First, participants' starting point for new activities is identified and various types of desktop uses are characterized. Then the way participants created the environment to easily access their documents and applications is analyzed. Next the use of resources and the setting of the environment while working on a task are described. These include details of the role of temporary organization, file names and metadata, and notes.

5.3 Work Environment or Portal and Desktop Use

One of the things analyzed during the interview was how participants structured their work environment, where they build it, which tools they use to characterize it, and which strategies they used to deal with files in this environment. Each participant had a preferred place that he/she used as the starting point for his activities (see Figure 1.) Using web nomenclature, the starting point will be referred to as the portal or home. This is the main space where participants would start their work, where they would store the

"Every time I switch on my laptop I check the top left corner. Like in a book the left top corner is the first spot I would look at."

"I put on the desktop or in my home directory the things I need every day, so they are closer, and when I'm done I put them into Documents"
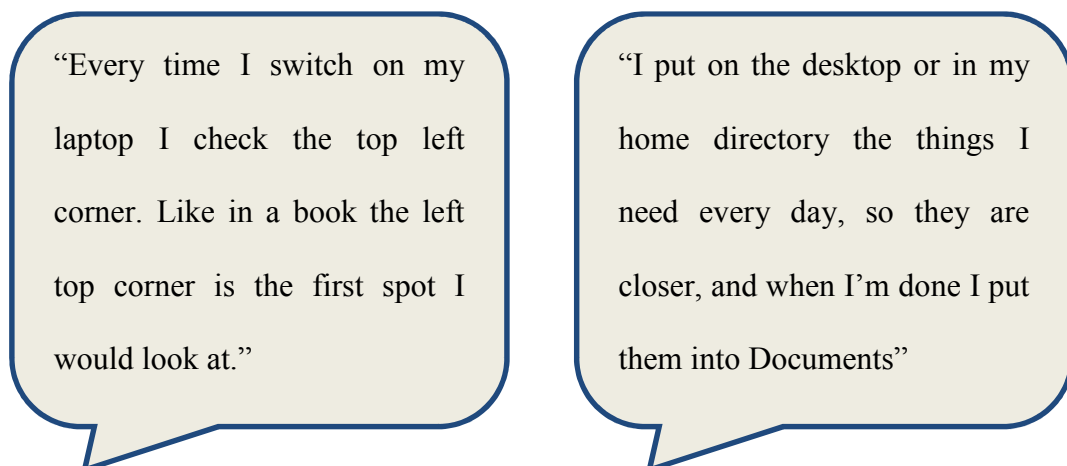
Figure 1. Quotes from participants: preferred places.

resources or the links to those resources for the projects that they are working on. It is

the place that they would set up in such a way to facilitate his work, to have an overview

of the projects or tasks at hand. It is also the place where they would place some items to

remind them of things to do; a manual to read that was downloaded from the web, a

picture to email a friend, etc. The resources relative to projects themselves could be

placed there as a reminder of the projects to work on.

For 50% of the participants the starting point was the desktop, for the others it

was a folder or a directory (see Table 3). When participants used folders as their main

context, they were either "My Documents" or the equivalent folder in Mac OS or Linux,

a home directory created under the local "C:\" disk, or a folder on a network drive. Many

described their main folder as their own personal environment.

The majority of participants, 87%, used the desktop to some extent. They placed

documents and shortcuts on it for either a short time of a few days or for longer and gave

it a structure. Only three participants did not use the desktop at all: two Linux users and

one XP user. The two Linux users did not use the desktop because they had to use the

command line to invoke applications on files (e.g., Emacs or Matlab), therefore they

couldn't make use of the graphic environment. The XP user did not like the fact that the

Table 3. Portal or starting point: desktop vs. folder.

Starting point	Participants
Desktop	50%
Folder	50%

desktop was always covered by open windows. She used it in the past, when the taskbar had the icon "Show Desktop" to minimize all the windows at once, but she had to change the operating system and the new system did not have that icon; therefore she stopped using the desktop.

Most of the participants (80%) used the desktop as a temporary place for documents before moving them into the folder structure, to get them ready to transfer to another device (for example to a PDA), or to send as an attachment by email. Only one participant used the desktop exclusively for transient files, all others used it also to organize more long term resources. Participants' use of the desktop can be categorized into the five groups of Table 4. The first three groups can be described as follow:

1) *Information Workspace*. The largest group of participants (50%) used the desktop as an information workspace with actual files and folders, not only shortcuts. example, one researcher kept the files that she was currently working on at the center of the screen. On the left of the screen she had a couple of folders related to projects she

Table 4. Type of desktop uses.

Type of Desktop Uses	Participants
Workspace	50%
DashBoard	13%
Minimum	20%
Temporary files only	3%
Not used	13%

has been working on during the last two months. When she was done with this work, she moved the files to the appropriate folder, and she moved the folders that are now on the desktop into "My Documents". Therefore the desktop represented the work space for what she was doing at the moment, while the file system represented the archival space.

Another professor had a similar strategy. He kept on the desktop several clusters of documents: one cluster relative to the classes he was teaching, one relative to the proposals he was writing, one cluster for papers, one for material given to him by his masters and PhD students, and another cluster for documents that he eventually would

Figure 2. Example of desktop classified as "Workspace": documents, folders, and shortcuts. The user uses the desktop as a place to work. He reserved a free space on the right of the screen to put the folder of the current project and the documents extracted from it.

have liked to read. All of the documents in one of the clusters will be thrown away once processed, such as student's thesis drafts. Documents in another cluster will be archived when they will not be needed anymore, such as the documents for the current class, or the final versions of the papers, or proposals. In particular he cleaned up the desktop at the end of every academic semester. Another user cleaned up the desktop regularly at the end of every day. See Figure 2 for an example of a desktop classified as a "Workspace".

2) *Dashboard*. Another group of participants (13%) used the desktop to organize shortcuts to applications, folders, and files, but not for placing real files. They often put

Figure 3. Example of workspace used as a "Dashboard": only shortcuts.

some effort in creating an organization for those shortcuts on the desktop. They also used the desktop as a temporary space for documents that they did not intend to put into their folder structure but that they eventually wanted to take a look at. The position of those documents on the desktop also served as a reminder that they eventually wanted to take a look at them. One of the users in this group put shortcuts to folders that she was using frequently, and that were deep in the tree structure of the network drive. She had about 40 shortcuts to applications and folders. A reason for some participants not to use the desktop was difficulty in backing up the contents. One user said he did not want to keep files that he intended to keep on the desktop because he could not back up the desktop easily. See Figure 3 for an example of a desktop used as a dashboard.

3) *Minimum*. The third group of participants (20%) used the desktop only for a few basic shortcuts to applications and folders. One subject for example only had links to "My Documents", Microsoft Internet Explorer, and Microsoft WinWord. He said he liked to have a clean desktop (see Figure 4).

5.4 Workspace Personalization

Participants expressed the importance of having the resources currently used on hand. Besides arranging shortcuts and documents on the desktop and in the folder structure, participants also customized the XP start menu, the XP quick launch bar, or the Mac OSX dock. They used the menu bar and the launch bar not only for applications, but also for shortcuts to the most frequently used folders. A third of the participants added application and folder shortcuts to the quick launch bar (see Figure 5
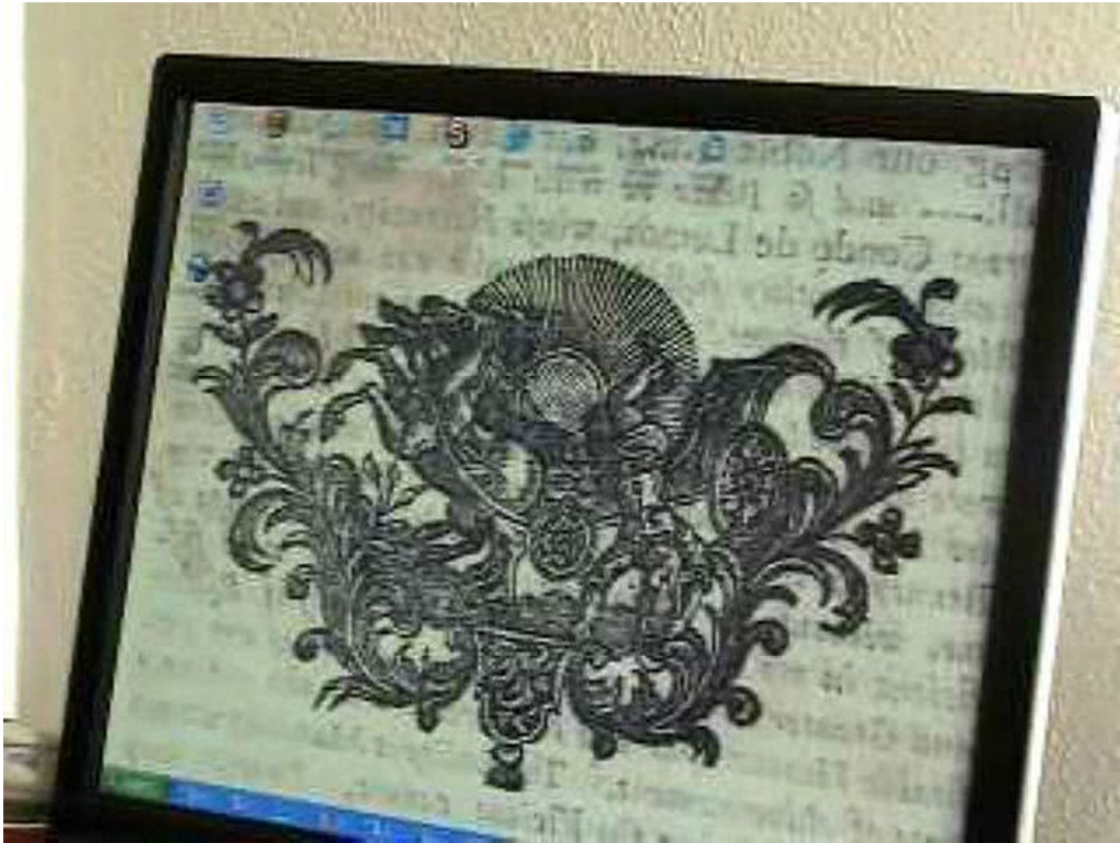
Figure 4. Example of a desktop classified as "Minimum". It contains few shortcuts to folders or applications.

and Figure 6). A small percentage of participants, 13%, modified the XP start menu to find frequently used applications more easily. They grouped similar programs, added shortcuts, or changed the names of the shortcuts. For example one professor used a green arrow for the folder containing the material of the class that he was recently teaching. He added this icon to the taskbar. He added another shortcut to the taskbar, the icon of a tree, pointing to the folder that contained files for his research on fruit trees. Another student had an icon with the image of a gear that was the shortcut to the engineering class he was taking. A couple of users had a particular organization for their shortcuts.
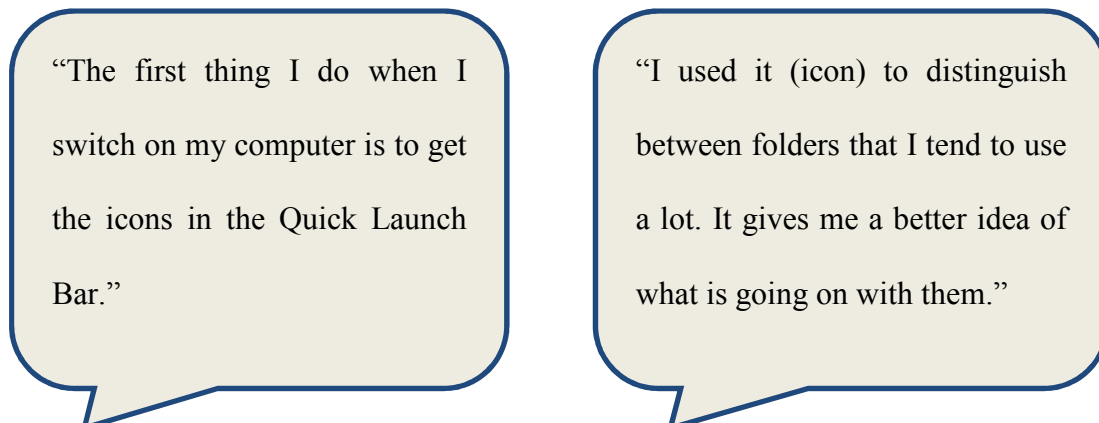
Figure 5. Quotes from participants: Quick Launch Bar and Icons personification.

Figure 6. Two examples of personalization of Windows' Start Menu.

One modified the organization of links in the XP startup button "All programs". He did not like to have a menu that was rolling over the screen occupying the entire screen in three or four columns; therefore he created subfolders, such as games, graphics and so

on. Another user created a folder on the desktop, and inside the folder he put shortcuts to frequently accessed programs. He used this folder to access applications.

The importance of having the resources currently used on hand is also exemplified in the habit that many users expressed in switching off their computer as little as possible, in order to keep the current context. One Mac laptop user said that she had switched it off a couple of times during the previous three years. She wanted to keep open all the documents she was working on.[1]

5.5 Folder Structure

Participants maintained either shallow or deep structure for their folders. 60% of users had a very shallow folder structure, at most two or three levels deep. Similar results were found in [Boardman and Sasse, 2004]. A couple of users had a deep structure: seven levels deep for one participant, and twelve levels deep for another other. One of them kept the tree structure very neat and he felt very comfortable with it. He was very careful in naming the folders and in filing his documents. He said, "I keep maintaining the system a lot. So I have a good performance."

Other participants had used a tree with deep branches in the past, but they found it problematic and changed their organization. One said, "Until last year I had a lot of subdirectories, but then I realized I was spending too much time looking for files and folders. Google Desktop could have been useful last year. Even if one of the problems was that I wasn't able to find directories and Google desktop searches for the content of

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1 In July 2011 Apple released the Mac OS X Lion version (10.7) of its desktop and operating system. Lion retains desktop status when the computer is shut down and restarted.

the files, not the name of the directories. But I solved the problem using fewer folders. Now I have few shallow directories and pretty much I know where my files are."

These observations raised the question of how people look for files. The next sub section analyzes how people search for files inside a folder.

5.6 Organization Inside a Folder

Participants frequently used sorting inside folders in order to locate files. They switched the sorting attribute according to their need. They used sorting by date, by name, or by type, with sorting by name and by date among the most used.

97% of participants viewed the files in icon view or details list. Two Linux users used the "list" shell command. 27% of participants kept the default sorting, the alphabetical one. Others changed it according to their needs. Some switched the order when they were looking for a file, switching for example between the sort by "last modified" and sort by name. A couple of users preferred sorting "by type." One user said she used "by type" in folders containing her papers so that she could visually isolate the pictures from the text. Another participant used "by type" on the desktop, so he could have all the shortcuts grouped in the columns on the extreme right.

Participants also modified the names of the files in order to force the order by name that they were looking for. 13% of users used a date in the name of the file in order to sort chronologically using the name. For example a professor called the folders with classes taught with names such as "2005_CPSC333 (Interaction)" (example modified) using in the same string date, class name in the university system, and class title. The

date was the order he wanted his files to appear. This order did not depend on the actual date of the file, the date when the file was last modified or created. The same user created folders for classes that he will teach in two years.

One Mac user had a folder on the desktop called "download" where he put things that he downloaded from the network. He created a script to modify the date of the file to be the date of when he drops something in. In this way he can order the documents inside by the time he puts them in and he had an idea of the priority of the files there.

Only one user used a spatial layout inside a directory. She was writing a book and she wrote a file for each chapter. Since her laptop crashed and the recovery of the data left some files corrupted, she had to correct all the chapters. Therefore she put all the chapters that she had already corrected on the left and the ones she still had to process on the right side.

These examples show how the order or organization inside a folder or on the desktop is important for users: they not only switch between one sorting and the other, but they also employ strategies to force a certain sorting.

The importance of establishing a certain order is also seen in Barreau and Nardi [Nardi and Barreau, 1997]. In their paper they wrote that "workers have a sense of control over the environment and confidence that they can find what they need with minimal effort." Our study confirmed that. All users in the study, when asked how they looked for files, said "I know where my files are" with the exception of one user who could find files easily only on the desktop and would often use search in her main

directory for others. Two other users were confident about their organization but relied on search for old files.

5.7 File Identification

Participants employed a variety of strategies to aid their identification of files inside folders and to make the files they are interested in stand out. Most participants used the system's sorting capabilities to locate files with approximately half of the participants leaving the default alphabetical sorting and half occasionally switching the file attribute being sorted.

Participants also used naming schemes to support identification. They extended file names with comments about the content of the file. One third of participants occasionally used a date in the name of the file. Occasionally participants added comments to file names indicating the document characteristics. One participant used the following convention for paper names, "Paper-name, version, date, collaborators, notes". She had comments such as "No images" and so on. An example name is "genetic 5-15 gb lb mj no_images" where "gb", "lb", and "mj" represent the initials of people who contributed to that version of the paper.

One participant only used spatial layout inside a directory, i.e., she placed the icons in the folder in a spatial arrangement instead of in a list.

Another personalization of the desktop was the modification of folder or file icons. Few participants used color and modified icons to aid identification. A small percentage of participants, 13% (one Mac and three XP users), changed the icons for the

most frequently accessed folders and one Mac user colorized files to make them distinguishable. She used red or green for important documents. One user tried to find the most adequate icons among the few provided by Microsoft. He said "I used it to distinguish between folders that I tend to use a lot. It gives me a better idea of what is going on with them." Another user was not satisfied with the standard icons provided by her system, and so she created new ones using the graphic program Paint. For example she used the image of an airplane for the travel folder, or a happy face for her dissertation folder. The extent to which she went to create new icons shows the importance that folder personification had for her.

5.8 Temporary Files

Participants had files that neither were archived in the folder structure nor did they belong to current activities. Participants may have wanted to do something with them, but for lack of time or other reasons they put them aside. These files can be divided in three categories:

- *To-Process.* Files that participants intend to look at and then throw away. They will throw them away anyway if they do not get to them for long time.

- *To-Keep.* Files participants need to file away in an archival structure.

- *To-Throw.* Files participants need to throw away but they have not got to them yet. They may never get to them.

Different participants had different strategies for dealing with potentially temporary documents. Some kept *To-Process* files on the desktop, either scattered on the

desktop surface or in a folder. Others used a temporary directory in the folder structure. One user had a "temp" directory on every network and local disk she was working on "I am a big fan of the temp directory. I use it a lot but nothing there is really important. Everything in the temp directory can be deleted." *To-Keep* files often were kept around because participants did not know where to put them or did not file them due to time constraints. *To-Throw* files were often kept in the root of the main folder, for example in "My Documents". One participant for example had 30 folders under My Documents and hundreds of files: "The folders are what is really important, but the documents under the root directory are not. They end up there and I don't use them anymore." *To-Keep* and *To-Throw* documents often were mixed together. Users said that among the tens of files to throw away in their main directory, there were files they intended to keep, but they did not want to spend time sifting them out.

5.9 Special Software

Documents are not always stored on the desktop or in file folders. Some participants used special software to organize certain kind of files. For example iTunes for music, Picasa for photographs, EndNote and BibDesk for references and related PDF files. In these cases the users simply dropped the media files in a folder and always accessed the files through the special software. One user did not even know where the folder was: he just opened the application to access and manage the files. These cases showed that even if documents are physically in the folders, some applications managed them in such a

way that participants do not store or feel the need to access them there directly, and they are not even aware of their location.

5.10 Notes

While working on tasks or projects it is common to maintain notes or to-do lists. What is the role of notes in the organization of project resources and how are they organized? During the study, I observed participants' practices regarding notes. They took notes in either paper or electronic form. They had both general notes and notes specific to projects. The note files were often given the same name, "notes" for example, across different locations. One third of the participants reported writing notes on paper. For example, one person reported that she sometimes writes a to do list in an email that she sends to herself, but she preferred to write them on paper so that when she completed an item she could scratch it off and feel a sense of satisfaction. Two thirds of the participants used an electronic form of notes at some time. Many participants reported using two types of files for notes: the first type general and the second specific to a project. The general note usually contained a to-do list, and was maintained in their main directory, or often on the desktop. The project specific notes were relative to projects and were maintained in the folders relatives to the project. One user reported that he used the equivalent of the famous "readme" file. He kept a file called "notes" in every project directory. Another user kept a sort of diary that he called "log" on the desktop in MS WinWord format. In it he wrote all his daily activities.

These practices add support to the idea that users have different work spaces, one for each project, and a general workspace. They also suggest that a system supporting a workspace organization should provide a note or to-do list feature for each project environment.

5.11 Changing of Practices

The way users organized their files is not necessarily the optimized for their current activities. Sometimes the organization had a long history. Sometimes it changes with time but other times it does not. A couple of users said they have been using the same file structure for more than ten years and they got used to it. "It is organized [tree structure] in a way that I have gotten used to over the years". They know where to put and find everything. One of them was still using the same structure he was using on the UNIX system, with filenames with three letters suffixes.

Other participants were not happy with their organization but they simply hadn't thought about changing it. They were bothered by the way they had to deal with gathering files in certain situations but changing it required too much effort, so they just let it be, or they simply hadn't thought about changing it.

Other participants improved their organizational strategies with time; they started organizing the files in a certain way and after a while they changed strategy. Users do not always have in mind the structure that they are going to create, but they constructed it over time. Sometimes participants adopted an organization that looked logical at the beginning, but it turned out to be impractical for use in their tasks. Then they changed it.

For example, one user was saving all the attachments received by email in folders with the name of the sender. After a while she realized that the documents of some users belonged to different projects and at the same time the documents relative to one project were spread in different folders. Since, with time and with the increasing number of saved attachments it was getting too difficult to locate the documents, she changed her strategy and she began to organize everything by project. She created one folder for each project instead of one folder for each sender. Therefore she first adopted one strategy that seemed reasonable at that time, but she later changed it to better match the structure to her use.

Other users adopted an incremental organization of documents with time. Some of them created a new folder when a group of documents in a folder reached a certain size, or when three or four documents collected in a folder represented a particular independent subject. The structure grew with the project. The position of a folder inside a folder structure also changed with time. It could have been at an upper level while the project was current and it could have been pushed back when the project was completed. This shows once more that the system is not only a place where to file and retrieve documents but it is a work environment and, as such, it has different requirements than simply filing or piling items.

5.12 Project vs. Archive

In the previous sections, I showed that there is evidence that participants think in term of projects. In some cases users explicitly mentioned projects. During the interview, one

user said, "When I save a file, I would like the system to ask me not the folder but the name of the project. Then the system should file the document using the convention for that project." When participants were asked where they kept their documents some answered talking about the projects they were working on. Duplication of documents in different project directories is another clue that people do not use the system only as a repository for their working files. The duplication of those files is not related to document archival and is not a way to provide additional back up, but it is a way to create a workspace and gather resources for the current project, even when some resources belong to different projects. The use of a space for temporary files is another indication that users organize their files in terms of the current work and not just as an archive.

5.13 Project Context and Work Environment

Previously I observed that each user has a portal. I described how participants use the desktop, how they personalize the start menu and launch bar, and how they identify and organize files. I now step back and present an overview of how all those ingredients combine to form a working environment. It is useful to distinguish between the organization of resources around a single project (*project context*) and the organization of groups of projects (*work environment*).

The *work environment* is the general space that participants use to carry out activities, to work and manage their projects and other tasks. The work environment is the place that users personalize in order to work on their current projects. It is also the

place where the user gets an overview of all the activities in which they are involved. The desktop is an example of a work environment.

Project contexts are spaces of a work environment which provide context for individual projects or tasks. A folder or a cluster of documents on the desktop are examples of project spaces. Kaptelinin [Kaptelinin, 2003] writes that "To carry out a higher-level task (or project), the user typically has to set up and manage a project-specific work context, that is, organize necessary resources to make them readily available when working on the project" (p. 353). The following describes how my participants set up their resources and environment to keep track of their projects' activities.

5.13.1 Practices for Project Context

The project context is achieved by organizing resources and by creating the space that is used as the working space. Typically participants collected the resources needed in a folder, or in a cluster of documents on the desktop. Besides just collecting content resources, people also use the project context to facilitate access to applications and to create an organization functional to the project.

The participants in our study used various strategies to create a context. For some participants the project context was a folder. For others it was a cluster of documents on the desktop. For participants using Linux, the context was often represented by a Linux workspace. Linux has the possibility to create multiple workspaces; it shows a map of them in the taskbar from where it is possible to select the workspace to make current.

Participants used different workspaces for different contexts. For other participants, the context was the set of open programs and documents. Some participants, in order to keep the current context, never switched off their computer. As previously mentioned, one participant expressed her desire for project-aware systems instead of generic folders. She mentioned that she would have liked to save documents by providing the saving dialog windows with the project name instead of the folder name. Currently, she has to browse the folder structure to locate the project's folder. Instead she would like to simply have a list of projects.

5.13.2 Practices for Work Environment

The borders between project context and work environment are often blurred in current systems since they do not offer project facilities independent of the more general working environment. Spaces can be shared between the current project and the set of all projects, such as when resources are placed on the desktop. End-users place resources belonging to separate projects along with general resources on the desktop and in the quick launch bar for easy access. The blurring between project and environment was problematic for some participants. One professor used two screens and both were completely covered by icons. Documents belonging to different projects were mixed together on the desktop. "All my documents are organized by activities. On the desktop, I use a chronological order, but then different activities overlap and it is a problem."

In setting up their environment, participants looked for ways to provide themselves an overview of all projects, to highlight the current project among all the

others, and to show a priority among projects. One user had folders on the desktop called "Burning" and "In progress" to visualize priorities.

The setting of the work environment shows an interesting characterization of areas on the computer. Roughly half of the participants, (46%), distinguished file locations on their computer as being a working context or archival. The working context was generally the desktop or their main directory, while the archival locations were contained in the deeper folder structure. Interestingly though, the other 54% did not distinguish between current and archival locations: they keep all their documents in the same folder structure, but many facilitate access to the current context by using shortcuts on the desktop. Therefore archived and current working documents are all mixed together in the same locations. What distinguishes archival and current documents is not the location but the structures people build to access them. For example, a professor with one folder for each class taught had about 20 folders in a subdirectory called "Classes" under "My Documents" folder. Present, past and even future classes were in the same location, in the same structure. But he had a shortcut on the desktop and in the launch bar to the folder with the class that he was currently teaching. Those shortcuts made current working folders and documents easily accessible.

Users that separated archival and working files expressed the geographical concept of "close" location. They filed archival documents in the directory structure and placed current documents in a "closer" position. The close position was the desktop, the root of the main directory, or the upper folder structure. For example, one user had three levels: the desktop for current files, the folder structure for archival documents, such as

"Home\classes\HCI\2004", and an intermediate location, the folder "Home\classes\HCI", for the documents related to the most recently taught HCI class. Another user kept all current and recently completed tasks on the desktop, and moved them into the archival section only when the desktop was too full.

The practices observed showed that users organized their resources around the concepts of working or project spaces. Comments from participants indicate they feel that current systems do not provide them with adequate support in this practice.

5.14 Conclusion

In the preliminary study, I examined how people organized spaces on the computer in order to organize their activities, and in particular at how they used documents and system features to structure their activities. The study showed evidence that participants think and organize their resources in term of projects and activities.

The results of the study show how users create environments that map to the structure of their activities or projects. These environments were either on the desktop or in folders in the directory structure. Users personalized this environment to facilitate access to the frequently used resources. They personalized the environment by adding shortcuts to the quick start bar or to the start menu, by modifying the image of icons, by creating shortcuts to folders or applications currently in use, and by spatially arranging documents in the folders or desktop. Participants also added information to the title of the files in order to force a certain order or to record information about the status of the file.

Following the observations on how participants used their desktop, I classified desktop use in five different categories that I called "Workspace", "Dashboard", "Minimum", "Temporary only", and "No use".

Participants had a variety of classes of temporary files in their structures. Some temporary files were waiting to be processed, others were in a temporary location waiting to be archived, others were just heaped somewhere, intermixed with other files, indefinitely waiting to be sieved out and then deleted by the user. These temporary documents are evidence that the system should be designed to be a working environment, not just an archival environment.

This preliminary study showed a range of practices employed by participants to structure their activities using files. The design of the system proposed in the next section aims at providing software that better supports user practices regarding their work environment.

6. SYSTEM: DESIGN AND IMPLEMENTATION

This section examines goals and rationale of the design, describes the design, and presents the actual implementation of the system.

An environment designed to support work activities is a complex and dynamic environment. The design and evaluation of such a system is similarly complex. My initial design stemmed from a combination of ideas that emerged during the preliminary study, from literature, and from my own experience.

The initial design is subject to revisions due to the process of implementation itself and due to the results of the studies with end-users. Design, implementation, and feedback, is a cycle that can be repeated several times during a project. In this dissertation I proposed an initial design, I did a first implementation of the system, and I conducted a user study on this first implementation. The results from this study will be an input for the next cycle.

The system implemented for the first cycle is a prototype, and only implements a subset of the features proposed in the initial design. The choice of the subset of features to implement in the first cycle is influenced by different factors. In some projects it is possible to test single features separately. For example during the development of the Xerox Star [Johnson et al., 1989] the look of the icons was tested in a standalone study. There are some features that can be tested separately in this project as well, such as the look and functionality of the flags, but my goal in this project is to study the impact that a certain structuring of the working environment may have on end-user activities, and

this can be seen only if an environment is implemented that allows some of the organizational features to be deployed.

For the first implementation I decided to focus on building the main framework or main structure, leaving some interface details to future cycles, such as usability of some components or widgets, and also leaving to future cycles implementation of more advanced features that build on the basic framework, such as an overview of the many workspaces. At the same time I wanted to build a system that allowed me to study the possibility of new practices in end-users. Therefore the system had to have an acceptable level of usability.

The study of new organizational practices in end-users is a complex problem. There are three main aspects to consider: designer expectations, coevolution of tools and practices, and interaction of the different components of the system.

Designer Expectations. When a system is deployed in the hands of the users, the tools and their many characteristics do not always follow designer expectation. Features introduced for certain purposes may end up being used in a completely different way and for accomplishing tasks different from the ones the designer originally had in mind. For example the file name is often used to store information related to the document that goes beyond the simple identification of the file, such as date or status of the document. Likewise, email is often used to send ourselves documents for storage or as a reminder of action to take on those documents.

Coevolution of tools and practices. Many features are needed to support end-users and these features coevolve with their use. The introduction of features in an

environment can initially respond to some user needs, but at the same time they may generate new needs. New features can be introduced that initially do not respond to any need, but they may become indispensable to the user with time. In Microsoft Windows, for example, the introduction of the thumbnail for pictures in folders was first expanded to thumbnail of documents, and it was then complemented with a view panel where users can see the full document without opening it.

Interaction among features is also an important aspect of a complex environment. One feature may be more or less important depending on the presence and interaction with other features. Therefore the design, development, and evaluation of complex systems require attention to the general trends provided by the systems as a whole, in addition to its parts.

The system implemented for this research is the result of a tradeoff between the implementation of a partial system that could be tested by users and could provide results that inform the next stage of the design, and the need to provide users with a system that is functional and usable. At the same time the system must allow the study of users' practices with regards to document organization in a work environment.

The next subsections introduce the design rationale, a descriptions of the features implemented in the design, and the design itself. The last two sections present the actual implementation of the system, and a discussion of some of the changes to the implementation effected as a consequence of initial study participants' feedback.

6.1 Design Rationale

The design idea being explored was to expand the concept of a computer file system and its interface as a work environment as opposed to a storage and retrieval system. In order to reach that goal the design aimed at providing participants with a system structured as a work environment.

The design was preceded by an assessment of end-users' current practices. The preliminary study of how end-users organize documents, described in Section 5, and previous studies found in the literature suggest a set of features that will support end-users in their practices related to the organization of documents in a workspace. Among the many features in a file system or computer system in general, I focused on those characteristics that allow users to integrate the organization of documents into their daily work.

I maintain that the following characteristics are important. Users should be able to:

- easily create project environments

- use files to more explicitly structure activities

- add project-specific metadata information (textual annotation) to files.

The design must provide infrastructure that enables the expression of meta-information about documents, and the use of document representation to express information about activities. Documents have a visual representation, or document surrogate, that can be used to find and access the document content. The document surrogate is traditionally represented by the document icon, the file name, or a

combination of the two. This file representation allows operation on the document itself, such as opening, deleting or creating a copy of the document. The representation can also be used to express information about the role of the document in activities. For example, the icon of a document in a corner of the desktop may be used as a reminder of an activity to do with that document. Similarly a group of documents can be split into folders "To Do" and "Done" to represent the progress of an activity. In both of these cases, the document surrogates are placed in a context to represent information about activities.

To enhance the ability of users to build project-oriented spaces from files and applications, I believe document and application surrogates need to provide:

- easy access to the document

- definable and accessible document metadata

- definable and accessible project-specific metadata

- specification of inter-document relations

While current file systems provide access to documents and, to a lesser extent, accessible document metadata, they do not support project- or activity-specific metadata or the expression of inter-document relations. For example, the desktop UI of Windows XP or later versions of the Microsoft desktop and operating systems have the tag feature on files, but to insert or see tags, the user has to click on the file and insert the text at the bottom of a page. Most users never notice this feature. Moreover the distance between the file surrogate and the place where people can see the tags makes them not very usable.

In general, a system needs to enable the user to treat document surrogates as objects with a rich set of properties and these objects need to be integrated in an environment that provides facilities to express activity-related and activity-specific characteristics of the documents.

Many of the characteristics described above are present in other systems, but it is the integration of all of them into the system as a whole and how they are used together that is important.

6.2 Design Properties

This describes the general properties that were incorporated in the design. Following the expression of design rationale, the ideas that derived from the preliminary study, from my own experience, and from literature are here translated into a set of properties desirable for the design.

The design provides a space in which textual information, visual information, and files are integrated together. The design provides a desktop-like space with the following characteristics:

- Persistent user-definable spatial arrangement.

- Possibility to add textual annotations to document surrogates.

- Possibility to attach symbols to document surrogates, such as flags (e.g. checkboxes.)

- Facility to annotate document surrogates using color or other visual cues.

- Spatial structures to organize files, such as panels, that are areas of the screen different than folders.

- A structure for representing contextual relations among files, similar to a web page, which glues all the components together.

- Possibility to sort according to names, date, type, or tag.

Some of these features are present in other current systems, but the way in which they are integrated together and the planned interface constitute a different system as a whole.

The resulting system combines some characteristics of a traditional file folder and some characteristics of a hypertext (web) page among others. Web pages contextualize links via their content and structure. Links are understood by reading the text surrounding them, the text on the link itself, or by looking at their position on the page. While links in a web page provide access and context to information, they are not representatives of that information. By acting on the links it is not possible to delete or move the correspondent files. On the other hand the traditional directory or folder has the capability to delete, create, move, and copy files by acting on the file icons. File manipulation by acting on the icon was introduced in the graphical interface in the Xerox Star system [Johnson et al., 1989]. The design in this dissertation integrates file-surrogate manipulation within an environment enabling the representation of relational and procedural context.

The system functions like a system with multiple desktops, where the desktop and file browser capabilities are merged. Underneath the interface, the system by

necessity has to sit on the current file system. The structures of the system are stored in file, folders, and databases. The design also accounts for how these structures are organized in the file system. One first idea is to separate the different workspaces in different folder, and to store in the same folder the documents relative to one workspace and the files that code the representation of the workspace structures. Each interaction with a document surrogate in the workspace is carried out on the file system. For example, if a document in the workspace is deleted by using the corresponding delete operation in workspace, the file would be deleted from the file system.

The working space contains several features that allow expression of document information and workflow or workspace information. The design integrates in the space common features such as flags to indicate activity status, tags, comments, and visual elements. One challenge of the design is to find a representation for all these features in the workspace and to produce a usable system. Another challenge of the design is to allow freedom in the expression of spatial arrangements or in the expression of document properties and their belonging to a particular workflow and at the same time allow the possibility to automate operations on sets of elements.

6.3 Design Details

This section introduces the actual design and solidifies the proprieties described in the previous section. It presents design sketches and the different features that have been the blueprints for the implementation. This design, even considering it a first cycle design,
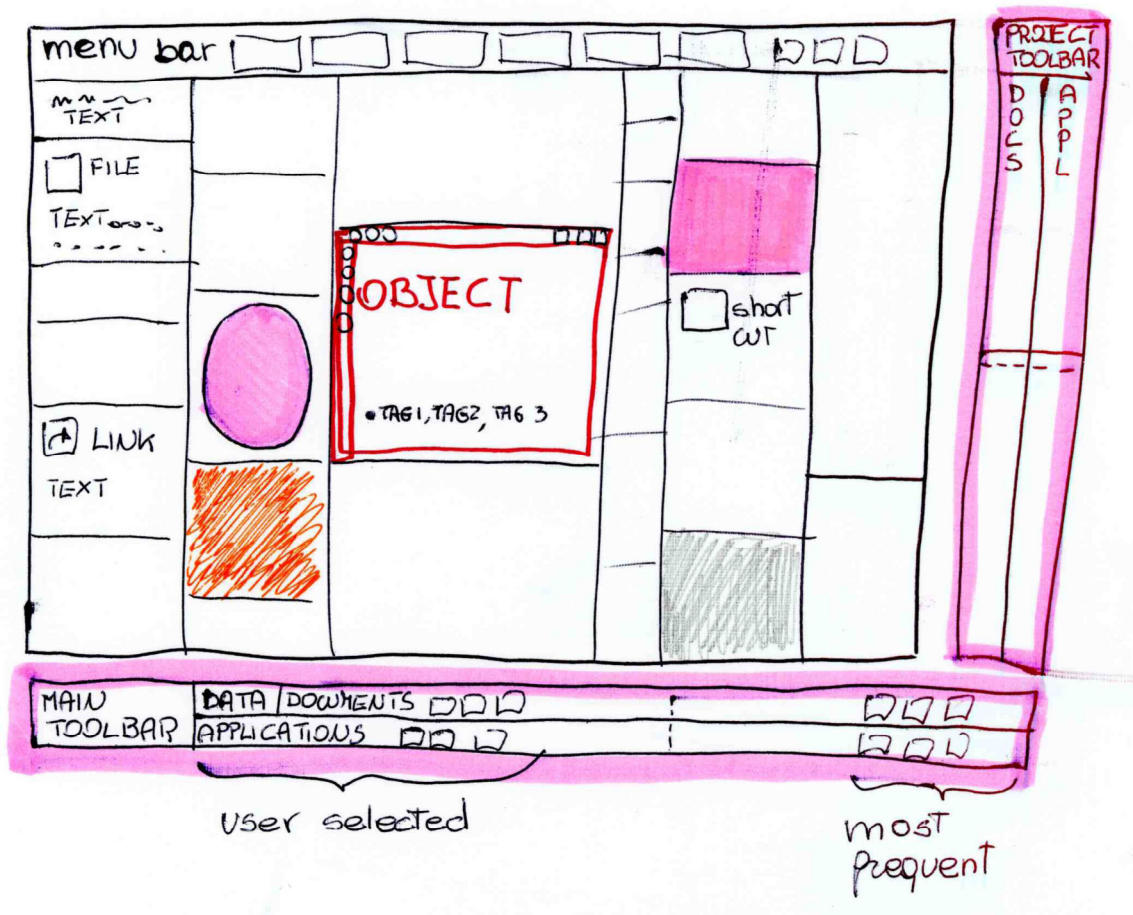
Figure 7. Sketch of a project space. The sketch shows the space organized in columns. Each column contains objects or elements of different types. Each object may have a different background.

represents a more complete system than the system that is actually implemented. As described in the introduction of this section, the first implementation aims at providing a usable system that can be tested and that can provide feedback for the next implementation, but it only includes a basic system. This design represents a more complete system.

The system consists of two types of spaces:

1. Main space: includes the collection of all projects

2. Project space: includes all elements of a single project.

The two spaces share a similar structure. Each consists of a window and two toolbars that the user can align along the preferred edge of the window. Since the two spaces are similar, only one of the two, the project space, is described. The design expects only one main space and multiple project spaces. The overall sketch of the project space is shown in Figure 7.

Both the main space and the project space contain two toolbars: one for the project and one for the main space. The toolbars have two rows/columns that allow the inclusion of shortcuts to programs and documents. One row/column is for shortcuts added by the user; the other is for shortcuts added by the system. The system adds shortcuts to programs and documents most frequently used.

The project window organizes its contents in columns. The user decides the number and width of each column. Objects are placed in the columns. Each object has a rectangular shape and the width is equal to the width of the column in which it resides. Invisible elastic objects are used for space filling to allow the user to position each object at several heights in the column. There is no horizontal scrolling, only vertical. This is to avoid areas difficult to reach, where both vertical and horizontal scrolling is needed. Columns divide the space in rectangular areas but at the same time they allow flexibility in the subdivision of the space. Many systems that users are familiar with divide the space in rectangular areas where areas in particular positions have a particular meaning. Newspapers for example have the title on the top horizontal area and the editorial along
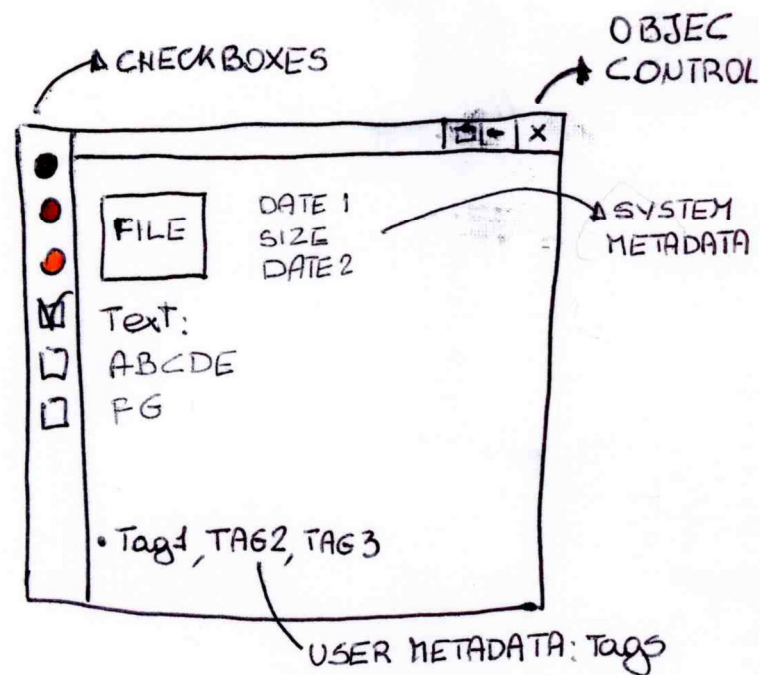
Figure 8. Sketch of an object or element of a project space.

the leftmost column. Web pages have menus on the edges and news webpages usually have the main articles in the center area of the screen or on the upper left area/column. Therefore users are already familiar with systems where a space is divided into rectangular areas and where the position of each area has a particular meaning [Kress and Van Leeuwen, 1998, Bernard and Sheshadri, 2004]. Each object or element of the workspace is of a certain type: text, file, shortcut, link, collection, or other. Each object has a background color and/or shape. Each object has a series of controls, such as minimize, expand, and delete. The object also features a series of check boxes, either provided by the system or customized by the user, and an area where the user can add tags, or labels, and an area where the user can add text or comments. Figure 8 shows the sketch of one such object. Each object also has system metadata such as time of creation

or modification, size, and/or type. A different view, a more traditional view, provides document sorting according to traditional fields, such as system metadata, name, date, size and so on, and according to tags or flags.
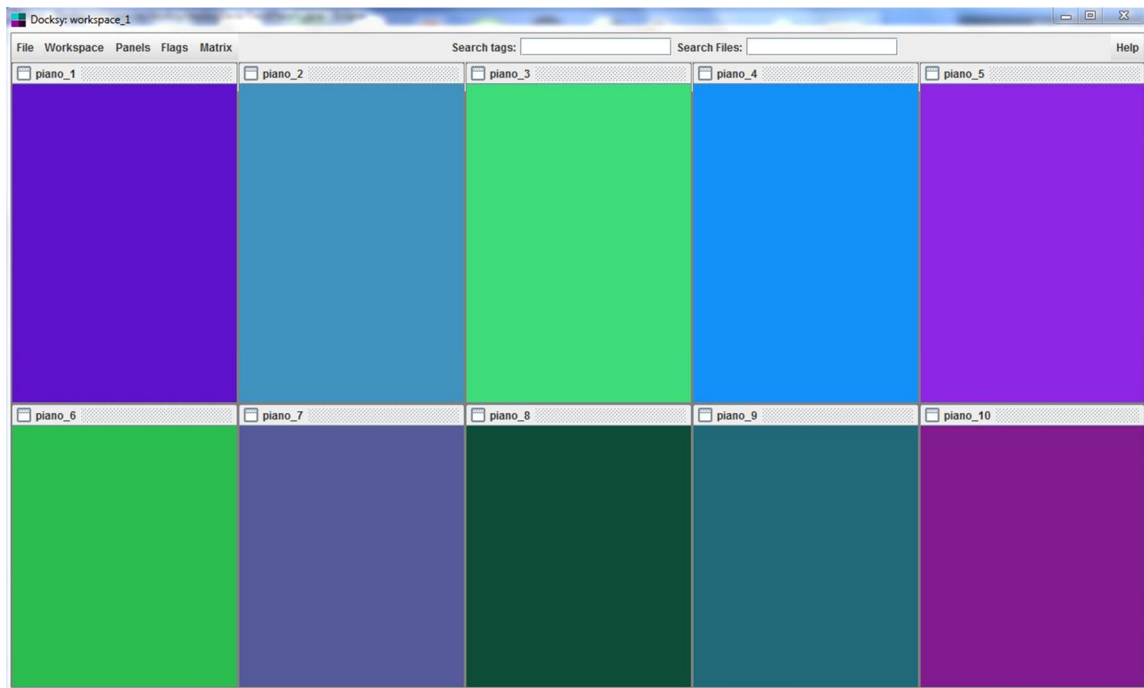
Figure 9. Screenshot of a workspace with ten panels. The colors are random.

6.4 System Implementation: Docksy

The system, named Docksy, has been implemented in the Java programming language. Docksy incorporates many of the features of the design, but some features are left for the following development cycles.

Docksy is a standalone program. It presents the user with an alternative desktop composed of different workspaces, where each workspace is overlaid with panels. When the user starts the software, the program shows the last used workspace or a new one if

Docksy is used for the first time. The user can create different workspaces, but only one at a time can be visible. The user can switch between different workspaces. Figure 9 shows how the program appears the first time the user starts it. It shows a workspace containing ten panels distributed over two rows and five columns.
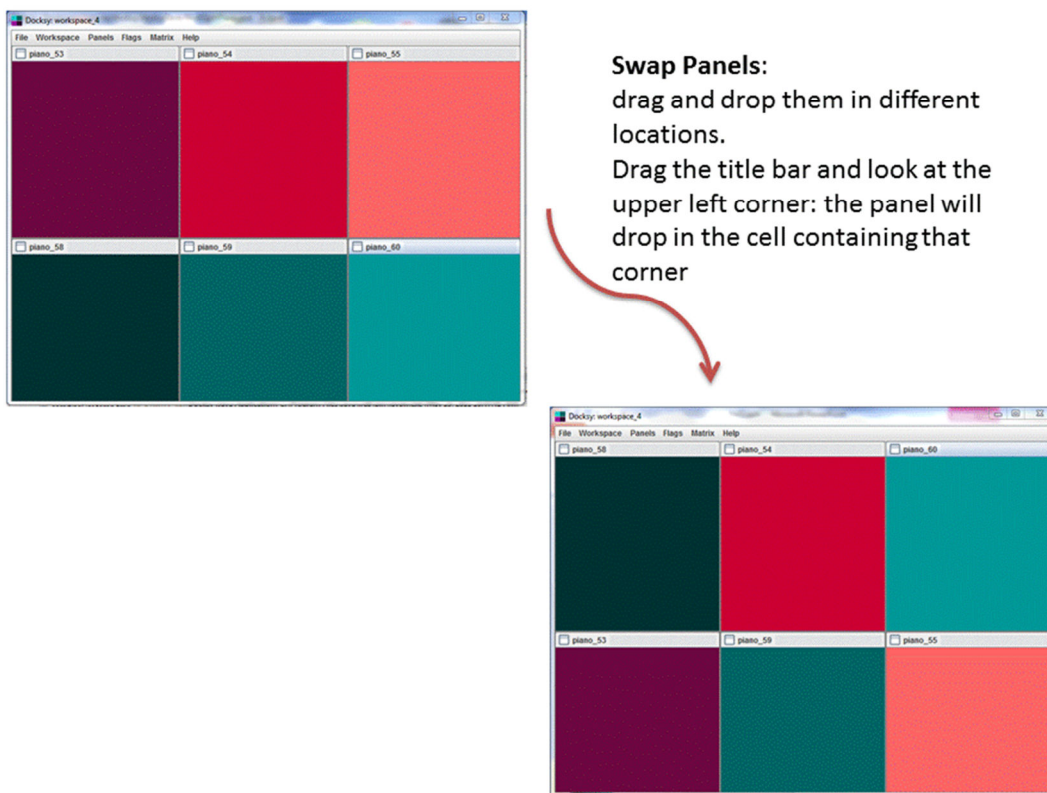
Figure 10. Panels can be swapped by dragging one onto another. Each panel will take the size of the new position.

6.4.1 Multiple Panels

Panels are intended to be areas of the desktop where users gather together items relative to a single task or project. The initial panels' colors in Docksy are totally random. The user can give a name to the panels, and swap the position by dragging and dropping

them (see Figure 10.) It is also possible to resize them (see Figure 11) or to change the number of the rows and columns (see Figure 12). When the number of row or columns is reduced, the extra panels on the rightmost columns or bottom rows are eliminated. The panels eliminated are stored and they can be brought back and substituted for a current panel.
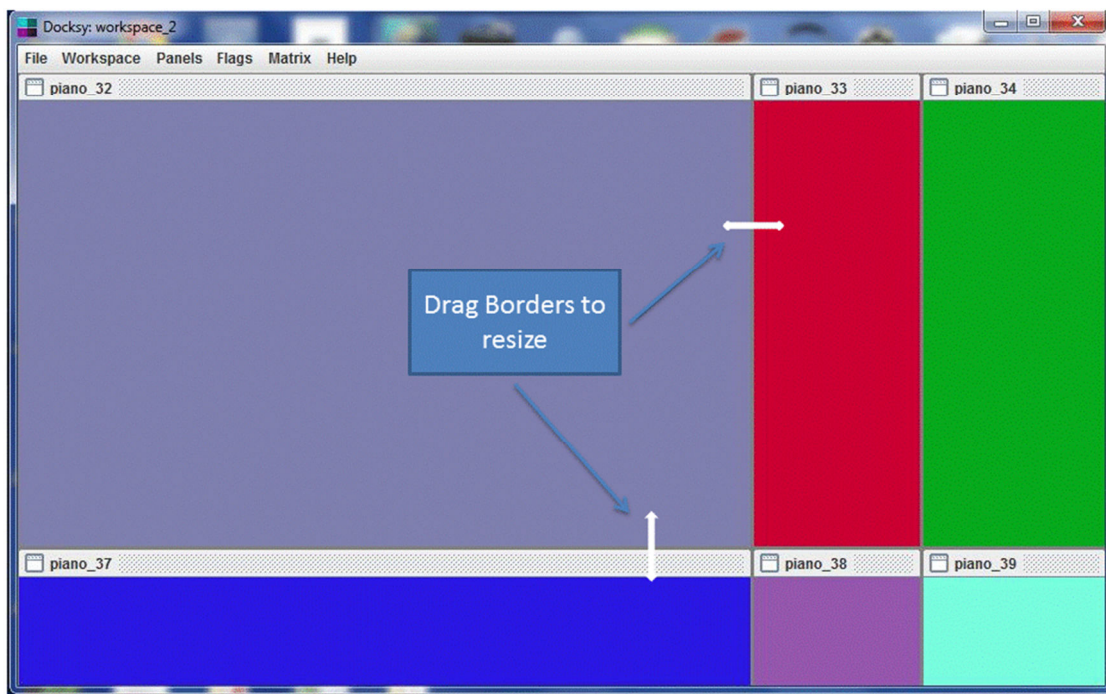
Figure 11. Panels can be resized by dragging the border.

6.4.2 Documents, Comments, Tags, and Flags

The user can drag and drop documents from the traditional file system inside the different panels. Once the files are in the Docksy environment, they are displayed in a widget consisting of an icon, a title, a comment text field, a tag text field, and a series of checkboxes or flags (see Figure 13).
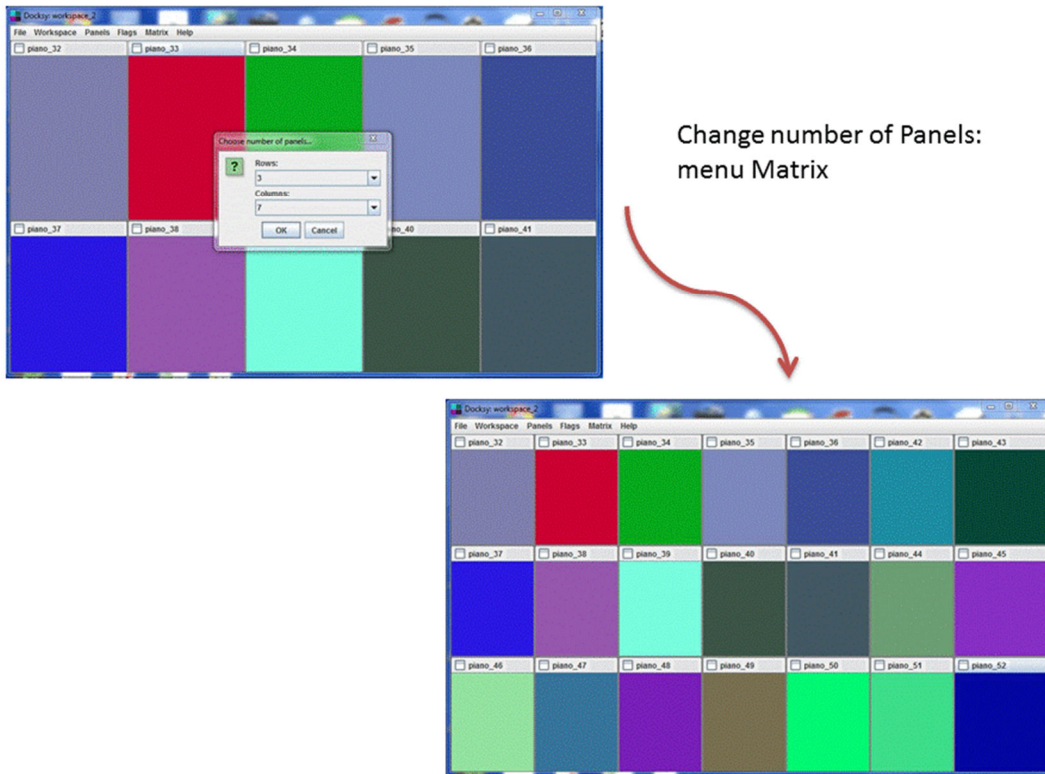
Figure 12. The number of rows and columns in a workspace can be changed.
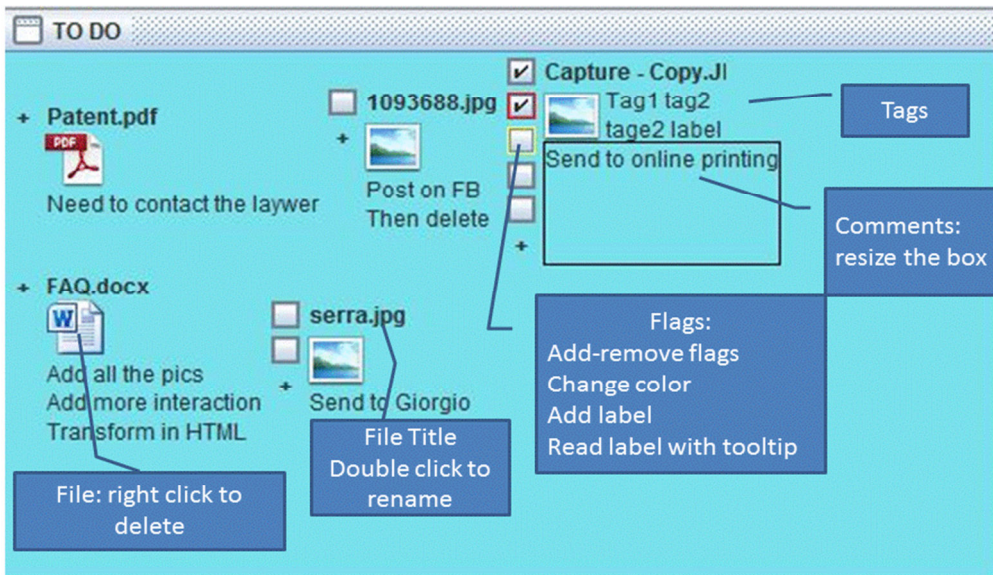
Figure 13. Single panel showing five files relative tags, flags and comment areas.

The document widgets can be dragged from one panel to the other inside the same workspace or they can be deleted from the system. The widgets can be resized. The user can change the title by double clicking on it. Figure 13 shows five documents inside a panel named "TO DO". The document titled "Capture-Copy.JPG" has five flags or check boxes, three of which have colors, the tag area and the comment area. Each checkbox has a label attached.

6.4.3 Interaction with the File System

All the files, this includes the user's documents and the files generated by Docksy, are maintained in a series of folders that the user chooses at the program startup. The description of the workspaces and panels is kept in XML files. Information about tags and relationships among files, panels, and workspaces is stored in a database. I chose to use the Derby Apache database that is a Java embedded database [Apache Software Foundation, 2011].

Ideally panels should substitute for folders, but the program runs on operating systems based on folders, and therefore it must use them in its underlying structure. Docksy creates a folder for each workspace, and all files belonging to the panels contained in a single workspace are stored in the same folder.

6.5 Usability and Future Cycles

The system implemented for this dissertation is the first in a cycle. It is a research tool but at the same time it has to be usable enough to be capable of eliciting feedback from

users about both the interface and their organizational practices. Besides design features not implemented because this is a first stage prototype that needs to be tested before proceeding to a more complete system, there is a long list of features that would have been nice to implement. The limited resources available during implementation required a tradeoff between making the product usable enough for use by participants in the research study, and making it a full featured product. During the initial evaluation of Docksy, some participants requested features. Being used to their regular operating systems, participants felt that the system was lacking some commonly available features. I implemented some of the requests, not only to make the testing experience more effective, and in some cases possible, but also to allow the participants to retain some of the work they did within the context of the evaluation once the evaluation period was over.

One of the requests was, for example, the possibility to run Docksy on a network drive. In the first implementation Docksy created a folder inside the user folder. In Windows 7 it was "C:\Users\user name\Docksy", while in Windows XP it was "C:\Documents and Setting\user name\My Documents\Docksy". After user feedback, I modified Docksy to allow the user to choose the desired folder at startup. This change allowed users to run Docksy on a local drive, on a network drive, or on an external drive. This was essential for users that had automatic backup only on their network drives, and not on their local disk, and for users working in labs rather than on personal machines. At the same time this feature allowed the possibility of having multiple Docksy environments in different locations. Another feature added following users' feedback

was drag and drop from the desktop or from the file system to Docksy. This made using Docksy much easier. Yet another feature introduced was the possibility to import workspaces from one folder to another, so users could transfer their work from one computer to another. All these features are not really essential to organizational practices, but still they made the experience of using Docksy more pleasant, and they made Docksy easier to use. The tradeoff of usability is often a difficult one. A slightly higher level of usability may make the difference between a product being used or not, even at the prototype level.

There are other features that belong to the list of features to be implemented at the next step. Among them are including scrolling for each panel and the thumbnail feature for each file. The choice for the scroll bar is not an easy one though. The scroll bar was left out on purpose. But testing with users revealed that it may be necessary, at least in the short term. The scroll bar is one of those features that should be tested together with other solutions, once the main framework of a follow-on system has been implemented and tested.

The follow-on implementation will take input from the user study presented in the next section and incorporate the remaining features proposed in the original design. That said, as is, Docksy provides substantial support for the representation of projects, the roles of documents in those projects, and relationships among documents.

7. EVALUATION

The third phase of this research project consisted of the evaluation of the design ideas and of Docksy, the prototype system.

Two types of evaluations were made. The first form of evaluation focused on specific system features, on their utility and on their usability; it was accomplished by a survey. The second type of evaluation focused on the participants' use of Docksy and in the system's potential for changing user practices regarding document organization in support of work activities. This evaluation was the result of the analysis of interviews and surveys.

7.1 Research Questions

The focus of the preliminary study was on the organization of documents in relation to task accomplishment or project management in current operating systems. The focus of this study is instead on the organization of documents in Docksy.

The research questions for Docksy's evaluation were the following:

- Which kinds of organization do users use in Docksy?

- Does Docksy support organization of documents for projects?

- What is Docksy's potential for changing user practices?

In order to answer these questions, a study was set up during which participants used Docksy for at least two weeks; they were then interviewed about their use of Docksy and given an online survey.

7.2 Study Setting

Twenty faculty, students, and staff at Texas A&M University participated in the study (see Table 5). Participants were recruited by sending an invitation email to various campus mailing lists, and through word of mouth. There was no overlap between the subject pools of the preliminary and of Docksy studies. All participants installed Docksy on their computers, running either Microsoft Windows XP or Windows 7 OS, and were given an overview of the software. They were instructed to choose at least one project and to use Docksy for at least two weeks as an alternative desktop or folder for that project(s). Once the two weeks were finished, a semi-structured interview concerning Docksy's use was performed. Each interview session lasted between five and fifteen minutes. A video recording of the screen and audio was collected during the interview. Some interviews were done over Skype, with screen recording.

The participants were all older than 18 and 26% of them older than 35; students and faculty belonged to different disciplines, both scientific and humanistic. Everyone had used a computer for more than five years, with 84% of participants having used a computer for more than ten years.

Table 5. Docksy study: number of participants for each category.

Undergraduate Students	Master Students	Ph.D. students	Faculty	Staff
2	4	8	2	4

They were all using Microsoft Windows. The particular versions of the operating systems participants used were XP, Vista, or Windows 7. Participants were not compensated for their participation.

Each interview started with the following questions:

1. Which kind of task or project did you choose for this study?

2. How many documents do you have for this project?

3. How often have you used it during this study?

4. What did you find useful in Docksy?

5. Did you come up with special ways to organize your files?

6. Do you think a tool like Docksy will make you change the way you organize documents?

7. What do you like of the way you organize your files using Docksy?

8. What do you not like?

The interview then proceeded based on the answers to previous questions and based on the observations of the use of Docksy by the participant.

All the interviews were video recorded and transcribed. The goal of the interviews was to understand the type of document organization employed with Docksy, and in particular the possibility of changing practices with Docksy. In addition to the interview, participants also filled out a demographic survey (see Appendix A) and a final survey (see Appendix B.) The final survey was administered online, after the interview, and participants could answer in their office or at home. The survey was administered online through http://www.surveymonkey.com/. The answers to the questions were

downloaded aggregated by question, and they were not associated with individuals. The results of the study are presented in the next subsections.

7.3 Features Evaluation

This first part of the evaluation examined the usability of the Docksy workspace, the panels, and the document's new features, such as comment text fields, tags and flags. It searched for answers to questions such as: how easy is it to add information to a document object? How easy is it to add checkboxes to a file? How useful is it to add text to a document representation? By document object or document representation I mean

Table 6. Results of final survey.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	count	average
Docksy easy to use	40%	55%	0%	5%	0%	20	4.3
Checkboxes useful	20%	40%	40%	0%	0%	20	3.8
Tag feature useful	32%	37%	26%	5%	0%	19	3.9
Comment feature useful	35%	45%	20%	0%	0%	20	4.2
I like the layout of the document	35%	65%	0%	0%	0%	20	4.4
New features easy to use	40%	40%	20%	0%	0%	20	4.2
I will like to use those features in the future	35%	55%	10%	0%	0%	20	4.3
Background grid useful	40%	55%	5%	0%	0%	20	4.4
Grid easy to use	45%	45%	5%	5%	0%	20	4.3

the visual representation that includes the icon, the file name, and the additional information with which Docksy enriches the file.

Participants answered a survey after using Docksy for at least two weeks. The survey (see Appendix B) presented two different types of questions, 5-point Likert-scale questions to examine the usability of Docksy and its features, and open-ended questions that allowed the user to write comments.

Table 6 reports the results of the questions using a 5-point Likert scale (1 = "Strongly disagree," 5 = "Strongly agree"). Twenty participants answered the survey. Based on the Likert scale questions, participants reported having generally positive
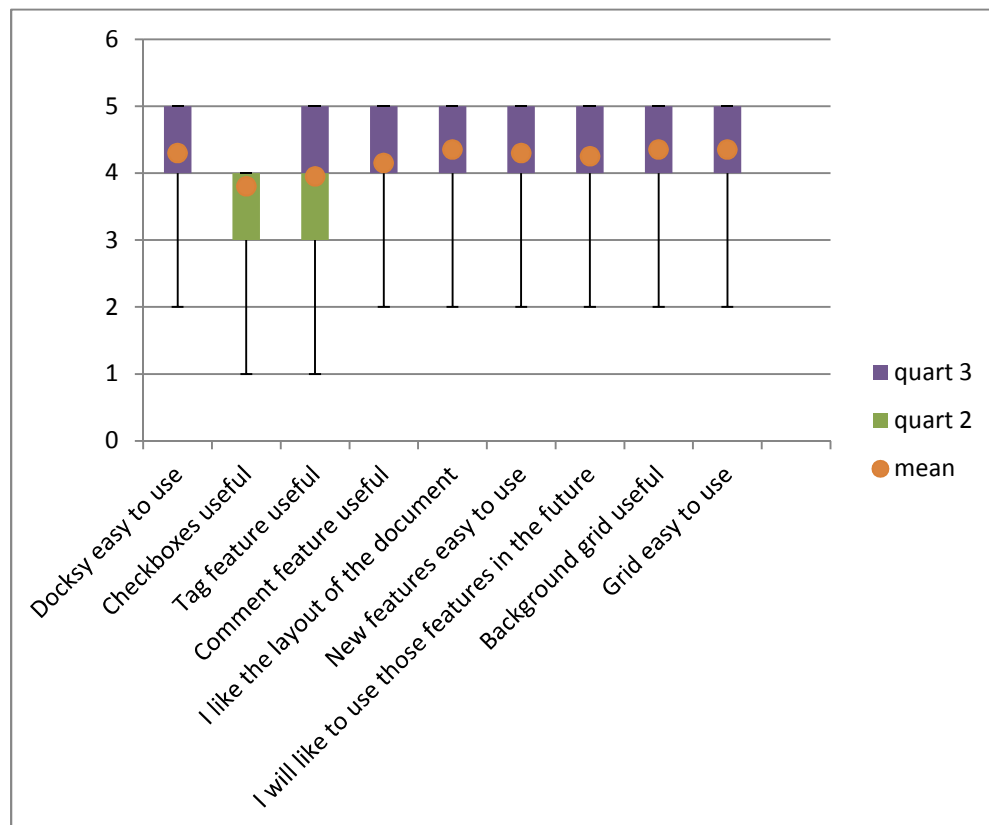
Figure 14. Box plot with mean for each Likert-style survey question.

experiences using the system although the results may be overly positive due to a demand effect [Orne, 1962]. Figure 14 shows a box plot with whiskers for the answers to the Likert-style questions and Figure 15 shows a plot of the percentage of participant for each answer. When asked to rate the system on its usability using a 5-point Likert scale, the average response was 4.3.

The grid feature, or panel structure, along with comments were the features that users found the most useful (average 4.4 and 4.2 respectively). This result is consistent with the finding of the interviews. Users also found tags useful, although with a lower
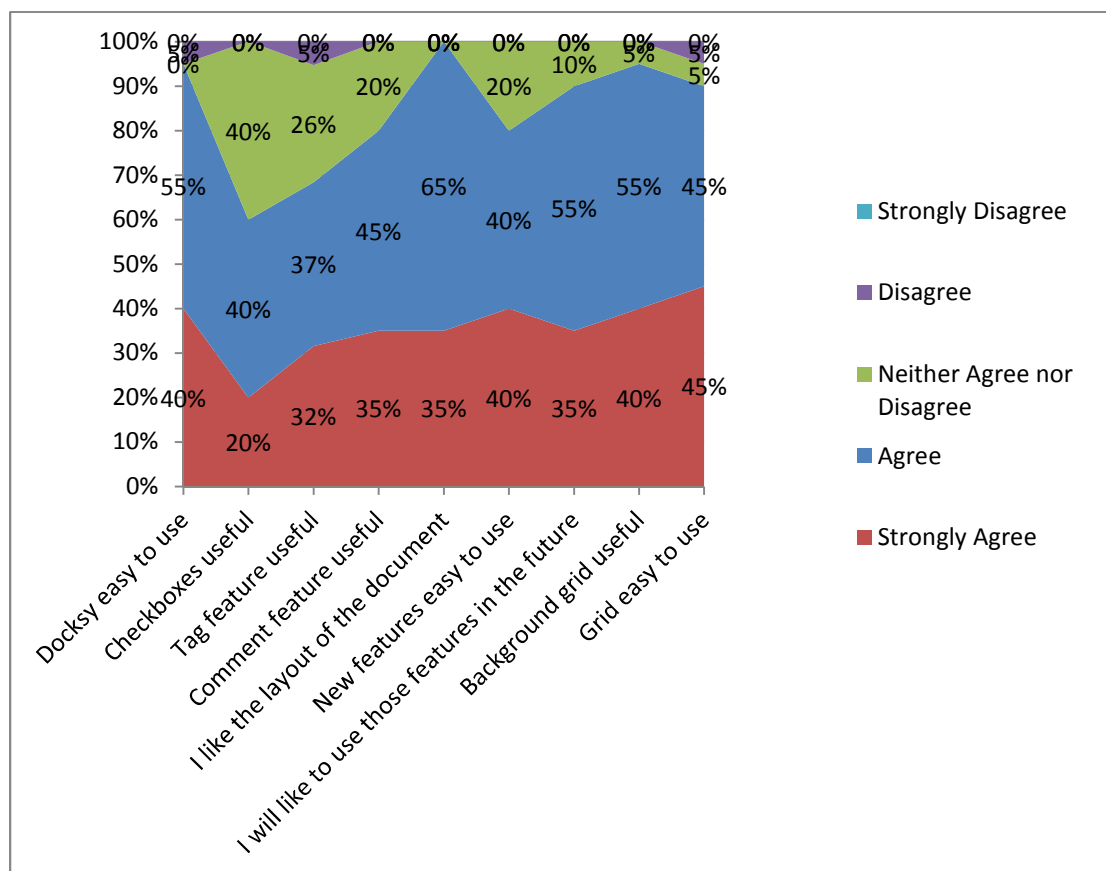
Figure 15. Percent of the participants' answers to the Likert-style questions from the final survey.

average (3.9). The survey question that garnered the least positive response asked participants to rate the usefulness of the checkbox feature. The average rating for this question was 3.8. While this was not, strictly speaking, negative feedback, I will present some of the possible reasons for this response later. Participants also liked the layout of the document structure (average 4.4). The layout is composed of icon, check boxes, tag, and comment.

Users mostly found the new features (panels, flags, comments, and tags) easy to use, with an average of 4.2. Although the result is positive, an improvement is needed for the usability of those features. During the interviews, I observed that some participants were not quite sure how to use the tag text field, or they did not distinguish between the tag and comment fields.

Participants reported a desire to use the new features in the future, saying that they would like to use those features in the future with an average of 4.3.

7.4 Practices in Docksy

The second and main objective of the evaluation was to explore the system's impact on activity organization and the potential for changing users' practices. The preliminary study characterized users' practices regarding document organization in current desktops and file systems. The system implemented for this dissertation aimed at offering better support for those practices. This evaluation aimed at finding which practices are supported by the system and which practices require a different kind of support. During

this evaluation the attention was cast not on the specific components of the system, but on how Docksy supports user practices.

This part of the evaluation looked for answers to the following questions: How did participants use the new system? Does Docksy support organization of documents for projects? Is Docksy's workspace a viable alternative to the folder structure? What aspects of the previous environment are end-users missing in the new environment? How do end-users forecast they will change the way they organize their projects?

Studies to establish actual changes in practices would require a complete system, and Docksy is a prototype only at the first stage of implementation, and as such it implemented only a part of the design. Changing practices would also require a much longer time for: users to get familiar with the new system; making them more confident in transferring to Docksy their actual work; and the new practices to actually develop. The system would also need to be integrated with the file system, and it would need to substitute for the current desktop. While the current implementation could not be fully tested to see how it changes practices, it was possible to study the system's potential to affect users' practices.

7.4.1 Method

The answers to open-ended questions in the survey were collected and the interviews were transcribed. Both were analyzed and keywords and concepts were grouped into thematic clusters. Interviews were transcribed into MS OneNote 2010. Answers to the online survey were downloaded from surveymonkey.com with answers clustered by

question, and copied into MS OneNote 2010. Keywords in the transcriptions and in the answers were highlighted. Sentences were then grouped by keywords. In presenting the quotes from the participants, resulting from either the transcriptions of the interview or the surveys, words or sentences related to the specific theme being discussed are bolded. Videos and screenshots of Docksy were also recorded and analyzed. Figure 16 shows an example of a screen shot from a participant.
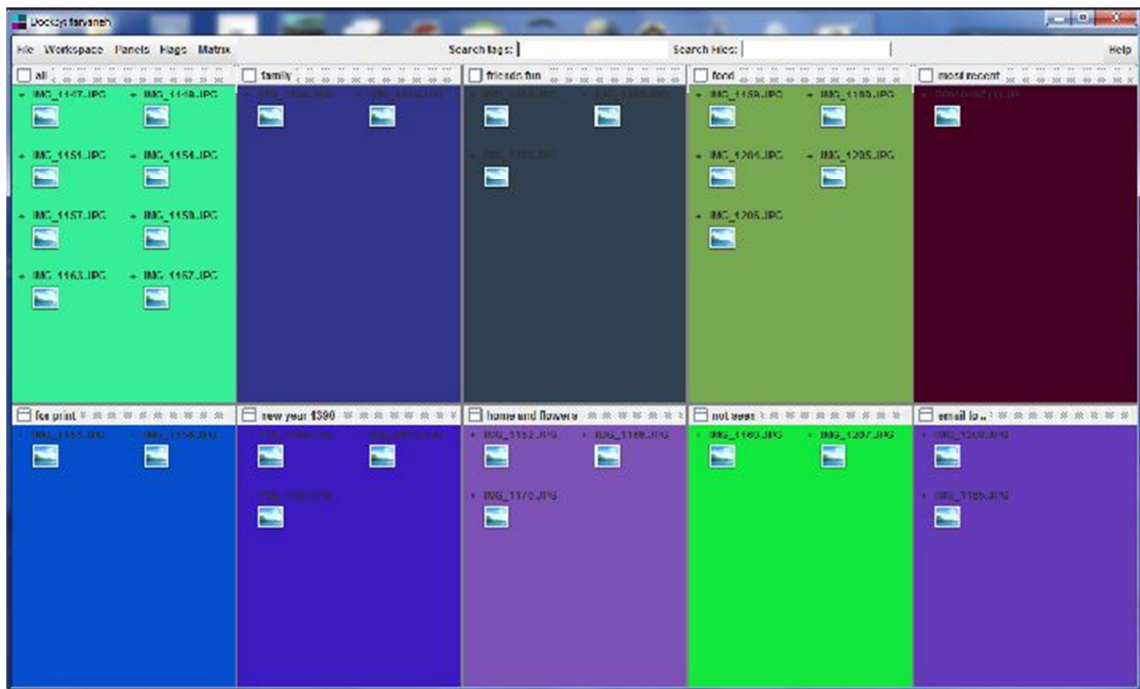
Figure 16. Screen shot from participant P1. She used Docksy for picture management. She had panels for "all", "family", "food", "most recent", friends, and so on.

7.4.2 Organization

One of the first questions during the interview asked for which kind of projects the participants used Docksy. Answers varied between general purpose uses and specific

projects. Some participants said that they used Docksy for general day to day activities, some as they would use the desktop, and others for a specific project. A sample of the answers is: "organizing files that had stacked up on the desktop"; "general day to day work"; "my thesis research"; "reshaping and integrating my archives"; "organizing reference material"; "organizing my pictures"; "for multidimensional sorting"; "organizing documents for the project I am working on" [from various surveys].

All participants, with one exception, only used one workspace. They used between four and ten panels, with an average of 5.5 panels per workspace (See Figure 17). Between three and six panels was the most common configuration. One user said "I felt more than four panels difficult to manage. I found four to be right, I juggled among them" [P6]. Users had on average 28 documents, or about 4-10 per workspace.
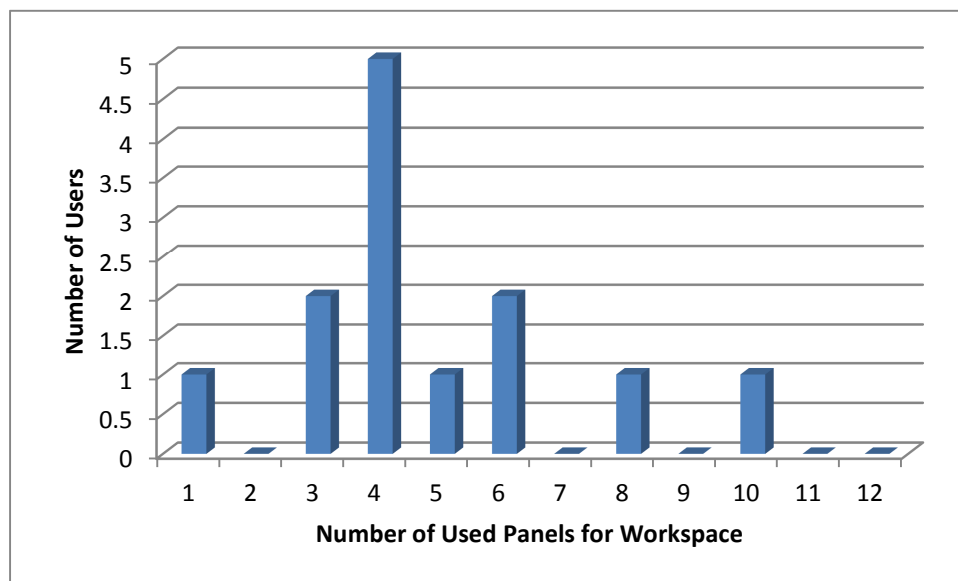
Figure 17. Number of panels for workspace.

The names participants used for panels suggest possible uses. A sample of panel names is: "to do"; "papers to read"; "interesting websites"; "family"; "friends"; "food"; "for print"; "games"; "songs"; "database"; "research"; "personal"; "expenses"; "draft"; "results"; "references"; "presentation"; "data"; "photos"; "report"; "desktop"; "network disk"; "working"; "my paper"; "chemical compound 1 and 2"; "teaching"; "homework"; "job material"; "radio interviews", etc.

The analysis of the interview transcripts and of the surveys produced a number of keywords of themes that participants frequently mentioned in describing their practices with Docksy. Those themes are represented by the following keywords: view or see, grouping, focus, flexibility, control, color, web links, project, and archive. The following subsections will describe each of these themes, together with a description of the use of panels, comments and checkboxes, and flags.

7.4.3 Holistic View

The possibility of seeing all the files without clicking and opening folders was the aspect of Docksy that participants found most useful. One user talked about "holistic view" of the workspace. Following are some quotes from the interviews. Keywords related to the theme are bolded. Figure 18 shows a screenshot from a participant.

"[it's useful to have] a **general overview** of what is going on. I did not have to go through my emails and look at my documents. Before this, all my docs were in Google docs. There are all these tags [in Google docs], but I cannot have a **visual view**; **visually**, it is not easy to look at them." [Participant 5]

"My main purpose is to **see all** of the documents that you have, separate them, because if we have different folders you need to name them and if you have them on the desktop it is not easy to find them, you need to open the folder and in each case you can see and manage all of them together. […] You have all the things in one part, exactly like the physical desktop where you can put all of the things you want to work with, at the same time you have access, **you can see them all together."** [P1]

"I wanted to add comments about the documents, so not to be forced to open them every time. In this way I could **see at a glance** the content of the documents themselves." [P26]

"I was just trying to organize this stuff in a different way, so it will be a lot easier
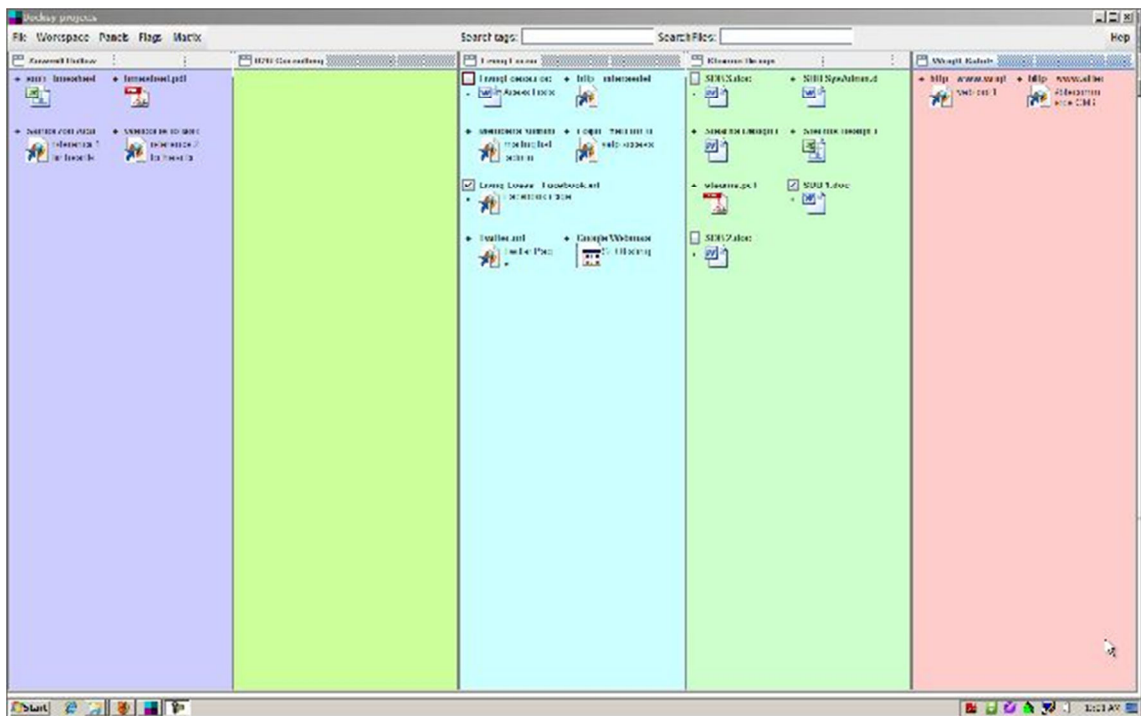
Figure 18. Screenshot from a participant P5, workspace 2. This was the second workspace for participant P5. He used it to organize a project.

to access and keep everything, **easy to see and keep separate**." [P2]

"Instead of just having them in different folders and going to check in each folder to check what is has and so on." [P11]

"In that way I could store multiple information in one place. If I use a traditional desktop or file browser, I have to use folders and I have to explicitly go to folders and choose. Here I get a **holistic view** of the documents I use on a day to day base. […] I think it is better than the traditional file browser; I don't have to use a lot of **clicks** and go through ever folder and see all the files. **I can see all of them in one place**." [P10]

"I could just look at the desktop and know where it is." [P17]

"Because if you can **see the entire panels** with all the files that are in folders and
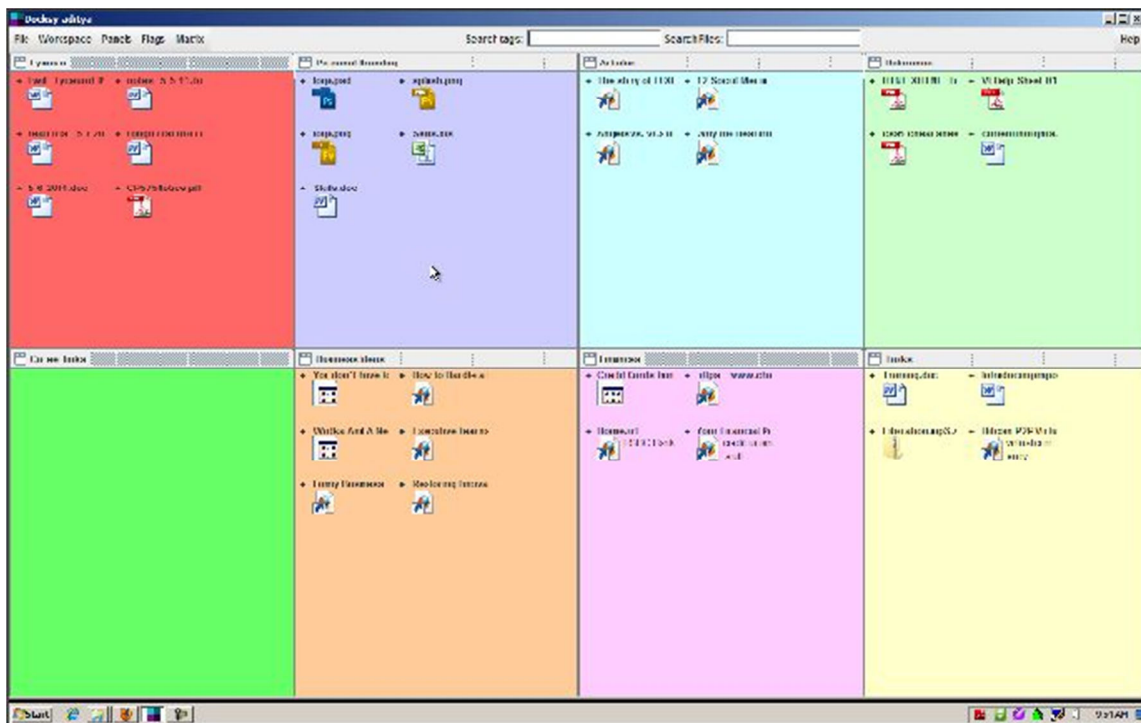
Figure 19. Screenshot from participant P5, workspace 1. This was the first of two workspaces. He used it to organize general information, including ideas, finance, thing to read, website to look at.

subfolder is useful, because sometimes if I go in here and all is visible is folder and folder and folder, unless I click on everything I wouldn't know which one I actually needed to look in. It would be easier in this one because it is visual and let you see more of what's in there." [P18]

Figure 19 and Figure 20 show a couple of screenshots from participants.Similar comments were found in the surveys:

- "I can **see all the different types of documents** that I work with on a day to
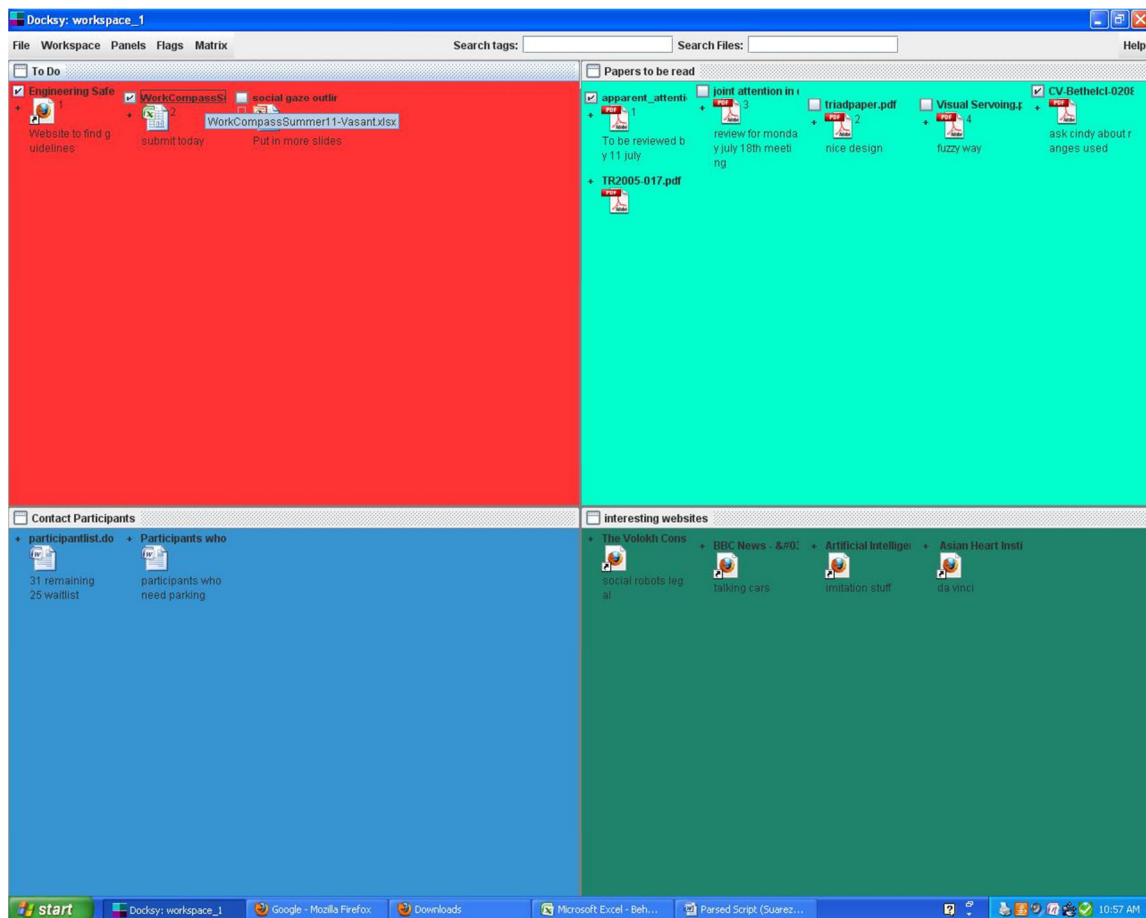
Figure 20. Screenshot from participant P6. The participant said that four panels were the right number.

day basis **in one place**.”

- “It is much better than looking through different resource folders for needed documents.”

- It lets me to have everything I need and I am recently working handy, **see all of them gathered at the same place**.”

- “It is easy to access the documents, helps **to easily locate** the files without searching/scrolling within a folder.”

- “This is great for keeping the documents **visually organized**.”

From the excerpts it is possible to deduce three main aspects that are important for users: first the possibility of seeing all the documents a person is working on in the same place, to have a holistic view. Second, the fact that users do not have to open multiple folders and browse the contents to find the files they are looking for. Participants often complained of having to do too many “clicks” in the folder directories to locate files, and search for the right folder. Third, the possibility of easily locating a file inside a workspace, because even though all the files are present in the same workspace, they are categorized or divided by panels, making them easier to locate.

7.4.4 Grouping and Separation

Docksy tiles the workspace with panels. Panels help users to group and at the same time to separate documents in a workspace. Participants found this feature very useful. They liked both the idea of grouping together related documents and the idea of separating them in panels inside the workspace. Moreover the grouping did not require participants

to explicitly give the panel or the cluster a name. The user was free to name the panel or to leave the default name. This feature is helpful in incremental formalization. Following are comments from the participants extracted from the interviews. Figure 21 shows a screenshot.

"It is nice to have them organized in different **concepts** or panels." [P5]

"I really like the idea of **aggregating the spaces**, the desktop spaces. This would be the section of things to do, and this of things over.[done]" [P7]

"I did not use tags; instead I preferred to **use panels instead of tags**." [P1]
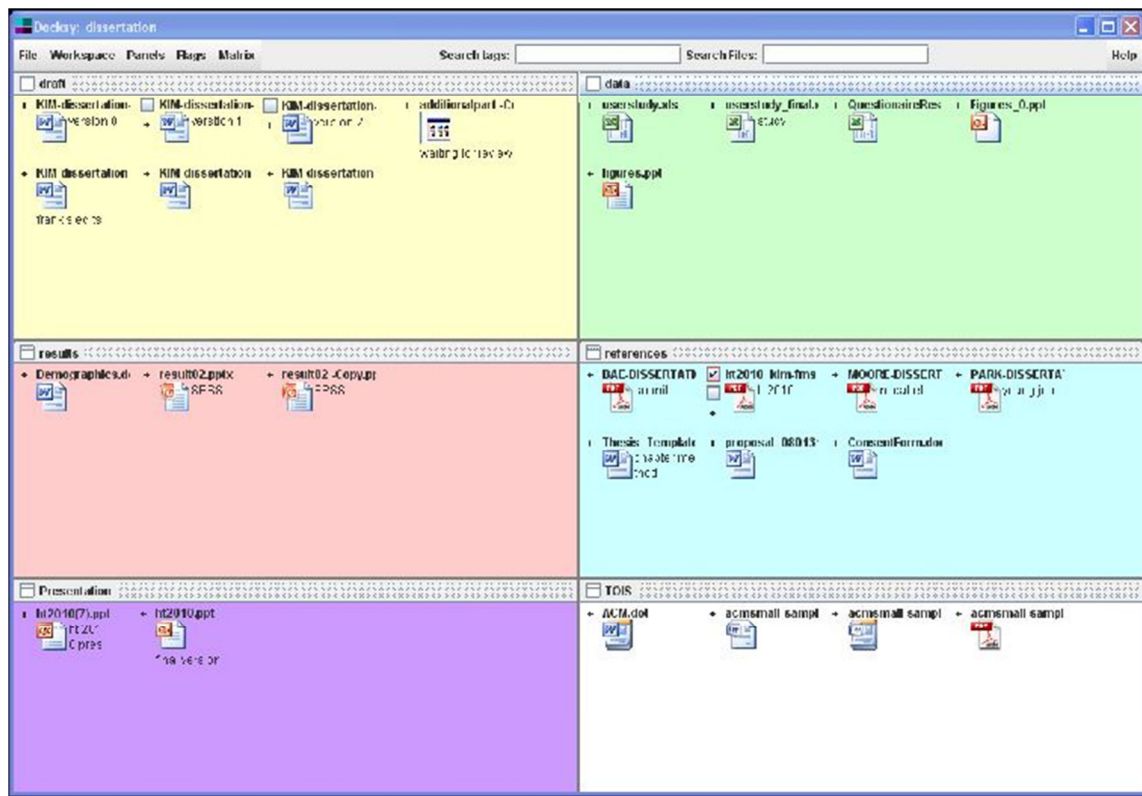
Figure 21. Screenshot from participant P5. He used the workspace to organize his dissertation, with panels for draft, data, and references and so on. He used labels, comments, and one checkbox.

"Easy **to see and keep separate**. [...]I just thought about different activities, in different grouping, in different panels. […] I like that you could add and remove panels, have different panels and **grouping**. Instead with the desktop you have one massive panel and you have to organize it by yourself inside that. In this way you have different **categories**." [P2]

"Panels: it is just a way of **grouping**, this goes together with this, so I don't confuse what goes with what, which source code goes with which page. No name on panels because few files; I can just look at and know what they are. At low volume a quick glance can tell me what they are for. If I had like four of five pages in this panel, for the same site, I would name it the flicker page." [P4]

"Because what I do, I organize the folders or the files on my disk according to my needs. But sometimes I start the computer and the files are mixed up, so this [Docksy] helps, so that I don't get mixed up and I know what happens, and **which is related to which** and so on. […] Having a tool like this will help in remembering which files are related to which." [P11]

"I would have used the different panels to **subgroup things** in there, to make **logical networks** within one subgroup, and then I can even make these different colors, if it is red for the rose, so you have a **color connotation**." [P14]

"Is good about Docksy that I can create my collection and I could better focus on my work. I can **differentiate each document by using the color** and also I can see which of them are important." [P9]

"I would like this to be merged with my desktop, so I would like to have the flexibility that even my icons could be **separated**, because I have a lot of these files in my desktop." [P6]

"You could create **segments**, panels is what you will call it." [P17]

"I used it to organize it some of my pdf article, I **categorize** them based on their topics. […] Right now I have a pdf folder and I have all of my papers in. But sometimes I need to **categorize** them, like High pressure freezing, R6, R3, R5, so that way I know this will allow me to go to the exact panel, and not have to scroll to and try to remember which author wrote which paper. So I can **categorize** all this as R6, that would be my title, and put all of the articles underneath that are related to it." [P20]

Following are some comments from the survey related to the grouping feature.

- "It will allow me to **better keep each project in its own panel** instead of creating different folders for each project I work on."

- "I like the way you can **group icons** better and exchange panels."

Reading these excerpts, it is possible to notice that participants juxtaposed the notions of panel-concept, panel-tag, panel-subgroup, panel-relationship, panel-logical-network, panel-activity, or used expressions such as "aggregate the spaces". This suggests that participants mapped the role of panels to one or more of the above concepts, and at the same time that they appropriated in their own way the concept of panel. For one participant the panel had a semantic meaning similar to that of a label. Grouping of documents into panels had different purposes or meanings. Some participants used panels to organize different work phases, some to build or highlight

relationships among documents, others to categorize or to subcategorize documents. Panels afforded the possibility of having a structured overview of a project, the possibility of keeping together and visible all documents relative to one subject, but at the same time to separate them. Participants reported that the separation helped them to distinguish among different groups/categories and at the same time to focus on the ones they were interested in; the separation also helped them in restricting the search or the browsing of documents to a subset of files, improving the efficiency of locating files.

7.4.5 Focus

Some participants stated that Docksy and its panels feature helped them to better focus on the current work, and to relax their mind from the clutter.

"It is nice to have them organized in different concepts or panels. It is **uncluttering** the mind. You can just look at it, where it is, and **focus** only on these things. I don't have to browse up and down and search anywhere. And if I am in the work mood I can just go in the work panel or workspace and **my mind is just here**, I can just look at what I need to see." [P5]

"Is good about Docksy that I can create my collection and I could **better focus** on my work." [P9]

"These panels are useful since I was able to categorize them, and **I was able to focus"**. [P10]

Panels helped participants to focus only on the documents in the panels they were interested in, without being distracted by documents in other panels.

7.4.6 Flexibility

Flexibility was one of the terms used by participants to describe what they liked of Docksy.

"I liked Docksy **flexibility**." [P26]

"I like the concepts of panels. I can add more panels or remove panels, which makes it **flexible** to use. I can have a lot of content in one place. And if I want to focus on one panel I maximize it and have one panel and work on this. You have the **flexibility** to work with different types of information." [P10]

"I would like this to be merged with my desktop, so I would like to have the **flexibility** that even my icons could be separated, because I have a lot of these files in my desktop." [P6]

"I like the **flexibility** of having as many panels as you want, so you can organize your document as you need." [P17]

From the survey:

- "It is **versatile**, user-friendly, enhances your ability to organize and manage data and files according to your specific needs."

- "I like its **flexibility** and the organization for workspace and panels."

- "I liked the **flexibility** and the holistic view it offers when working with documents."

Participants used the word flexibility and they used it to refer to different characteristics: the flexibility to move panels around the workspace, to change the number of panels, to move documents from one panel to the other, the flexibility of

using different types of data, or the flexibility of separating documents in various panels. They also referred to the flexibility of using Docksy in general.

7.4.7 Web Links

Besides organizing files that were originally on the desktop or in the file system, some participants imported web links from the browser title bar. Some participants said that they liked the possibility to drag and drop web links. Some participants used one or more panels for references. One user said that he preferred to use panels to the browser bookmark section.

"I found particularly useful the **web links**. I have a panel with internet links I go to often" [P21]

"I kept Docksy open during the day as an alternative to desktop and browser, instead of using browser **bookmarks** I am using shortcuts in panels."[P10]

"I save here web **shortcuts**, stuff I need to read, and when I have time I read them and then delete." [P5]

"I organize in a panel links to web pages with content I need for school." [P28]

Participants had panels titled "Interesting websites", "Web Pages", "Web", and "Links". This is an indication that besides organizing local documents, participants see Docksy as a working environment, a place to organize their web-based documents and references as well.

7.4.8 Comments, Tags, or Flags

The features comments, tags, and flags or checkboxes, while they were considered useful in the survey (4.2, 3.9, and 3.8 respectively on average out of 5 points), were used by few participants during the study. Participants who used them, said:

"It is useful to add tags to documents to describe their **topic**, and search for them, because one document may have more than one topic." [P26]

"If you have a project you can add checkbox and **check off** whenever you completed something. And add comments, to better **remember what that file is**." [P2]

"So Docksy could be like a **digital post it note**, that's what I wanted to use it for. And this post it notes I would use it for me to provide **pointers** to find files and to structure my desktop better. Everybody has certain **keywords** that you associate with a file, whatever it is a paper, or a picture, or a manuscript, or a data plot, whatever, and you always have certain **keywords** that you remember that. And I was thinking, if I had associate these keywords with this files, than I just search for this keywords, and it will give me access to these files. Which kind of keywords? Oh, there are manifolds, tons of possibilities; it depends by the content of the files. When you read a manuscript, the first impression you get from the manuscript, the first time you look over the manuscript, you see things and you gain **insights** into the manuscripts that are quite amazing actually, you find things that when you are looking for them you don't find afterwards. So the first time you see that, you jot down these keywords that you read there. So that means that the first impression you have, you jot them down, **this first impressions**, they don't need to have any order, they are just keywords. And then **you use these keywords to**

find that documents. Because you had these first thought about this paper and a year later you don't remember maybe the author or anything, but you remember the first thought you had." [P14]

"I find tags useful, I didn't put many comments, but [I used them] in some cases, if I wanted to express **what some document was for**. This shows that this file is my advisor review, this one is waiting for the result of the review, not much, but, whenever I need. I think it is useful. Checkboxes: used to display how important the document is. I used some visual cue and check boxes." [P9]

"I like tagging and the ability to **search for tags** as I think this is becoming the norm this day." [P10]

"I also used tags as a **priority**: if I say one I will do that first. I used some comments to understand **what the paper is about**." [P6]

This participant would add numbers as tags to file, and use those numbers to establish a priority on his documents, or on the operations to perform on those documents.

"I like the comment thing if there is a volume of files, I like the fact that you can write stuff down for each file, and **what you did, and what you edited**, and things of that nature. So I think in terms of organization that is important, because sometimes when I edit, what I do I create a new folder for things that have been edited and I will put the edited ones in the edited folders, where here **I just put a comment that it has been edited, or use a checkbox. I just find writing it is easier."** [P21]

"The ones in the desktop **required all the extra tags**, because usually they have names like maestro, that is the name of the form, but it doesn't tell you anything about the PI, which researcher it belongs to, all those information that will be useful, and I didn't put it **because I cannot change the name of the form**, but I spent a lot of time clicking, opening." [P17]

This participant was working on documents sent to him by other people. He had to download them from a shared network disk, edit them and put them back on the shared disk. The names of the documents were the names of the forms, therefore many documents had the same name, and since he had to put them back in the shared network he could not change their names. This caused problems because he had many documents to edit that all had the same names, and he could not distinguish among them by just looking at the names.

"Beside the article **I would write beside it what I still need to do** to get information from those." [P20]

"**I used tags** in Piano^2 3 **for** statistical data set." [P23]

Below are some comments from the surveys.

"I was particularly impressed with the comment feature that **enabled me to keep track of what I had done** with a certain file. Since I prefer detail it helped me to recall changes, edits and things of that nature."

"It will help me **summarize** the main topics of a text so I can find at once all the texts related to a topic."

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2 Piano is Docksy name for Panel.

Participants used tags and comments for several purposes. One use was for prioritizing among documents. Another use was for adding keywords in order to be able to find them quicker later, or to classify them. Another was to add notes about the content, to avoid opening them again. Another use was for adding extensive comments to the files, to supplement additional information about the content, or to add summaries. Yet another use was for adding information about work or operations to do or already done about that document. Some participants said that they did not make use of tags because they worked on Docksy only for a limited time, and they would have used those features if they had the chance to use it for a longer period. One participant also said that she did not want to put too much effort into it because she was afraid that she would have lost her work at the end of the study.

7.4.9 Project

In describing how they used Docksy, participants referred either to projects and work, or to document organization or management. This subsection reports examples of cases in which participants described their use of Docksy in terms of project or work, while the next subsection covers document management.

"I have two workspaces. The first is a general overview of **things going on**, with both general things and professional things. I used it to organize bookmark and **things to do**, things to read, just to get a general overview of **things going on in the week**. There is a panel with notes from conference calls. The documents I put there are the ones I need for immediate references, which I will probably need for the next one week. In this

panel there is a resume. **These three panels change dynamically**, I save here shortcuts, stuff I need to read, and when I have time I read them and then delete. These two panels are **to do lists**. In this panel are references. The second workspace is just for projects, **the main project I am working on**. I will need these docs in this panel for the next one week." [P5]

"I used it [Docksy] for general things. How I would have used my desktop, I used this. Once I wanted to do **work** over the week. At the **starting of the week I added in the panel** on the top left, and whenever I **completed** something I put it in the lower left panel." [P7]

"I just thought about different **activities**, in different grouping, in different panels." [P2]

"Here I have mainly references. This is what **my day to day tasks** requires. I had Docksy open for a while. Then my task changed and I don't have to refer to this anymore." [P4]

"I used Docksy generally**, for whatever I was working at that point in time**. I felt like better organized. I was using it more to categorize things, what I wanted to do, to **prioritize my work** in term of documents." [P6]

"I had a panel for a **to-do list**: I changed the title of the third panel to to-do list, then, beside the article I would write **what I still need to do to** get information from those." [P20]

"Panel number 7 was my **working space**. Whatever I was working on was in this panel, and then I will move it back in its original panel. […] In the future I will use this

product for each scholarly article I am gonna use. I will divide the screen into **the stages of my research project**." [P23]

In the survey, when asked how Docksy will change the way they work with documents, some participants mentioned project or work.

"It will help me organize each **project** better into **phases and components**."

"Leads to **better organization of my work**."

"Organize work better."

"It lets me to have everything I need and I am recently working handy, see all of them gathered at the same place."

"Help me organize **bigger project** better."

From the above quotes we can deduce that Docksy has been used to work on projects or to organize daily or recurrent tasks. Even the creation of references sections or panels is an indication of a work environment as opposed to an archive environment.

7.4.10 Document Management

Participants also referred to their use of Docksy in terms of document management or archive. In the survey a participant said.

"It allows me to build a **meta archive** relative to contingent necessities. For example with files for exams to be used in the current month, leaving the original **archive** unchanged."

During the interview participants referred to search or finding files:

"So that's why I saw this huge possibility to use Docksy as a **mental sorting program**. Because I have something in mind, I put it down, and if it is an image, it is - This image is good because of …- whatever, I can give it one note, or two or three notes, it doesn't matter, because you have the ability here to associate it like a posted note. And that is a very good idea, that's the strength of the program. By combining ascii with binary, keywords, keywords notation, with some imaging is a powerful approach. It's a **multiplicity of approaches, for finding things**." [P14]

"You have tags like labels in gmail. In the future there are lots of files and I could easily **search** based on the tags." [P10]

In response to the question in the surveys about what did they use Docksy for, participants answered:

"I was organizing files that had stacked up on my desktop. "

"Reshaping and integrating my archives."

"Collecting references for my thesis, music videos and news on the web."

"Organizing reference materials."

"Intended to use it for multidimensional sorting/filing."

"Just general grouping of icons, not really a task in particular."

"Organizing my pictures."

These quotes suggest that participants used Docksy also as a way to organize archives or collections of documents.

7.4.11 Color

Participants liked the use of background colors, but at the same time they did not like the colors proposed. Every time a new workspace or a new panel was created, Docksy set the panel or panels' background color using a random generator function. The user could easily change the panel color by right clicking on a panel and by selecting a new color, but still the first impact on opening Docksy or on creating a new workspace left an impression.

"I like being able to choose my colors. That was very helpful, because it **make me feel good** with colors, I know it is silly, but …" [P20]

"Plus it is **nice to look** with all the colorful things." [P17]

"I liked the colors of the panels, **so you can easily distinguish** what was for what. […]You can also look at using not primary colors, **but softer colors**. And **choose the four best combinations of colors that go better together**. Otherwise the whole is lost on me. You can see these fours are conflicting with each other." [P6]

"Colors help to separate the panels, but if you have something that doesn't remove the simplicity, but it makes it a little bit more appealing." [P21]

"I would have used the different panels to subgroup things in there, to make logical networks within one subgroup, and then I can even make these different colors, if it is red for the rose, so you have a **color connotation**. So you have image connotation, color connotation, word connotation, so that will give you a very good way to organize a lot of data." [P14]

Colors were also used as borders on checkboxes, but they were barely noticeable. Overall participants liked colors, but they wished for better selections. Beside the look, colors were useful in subcategorizing the different document groups, and in better segmenting the screen.

7.4.12 Miscellanea

Participants reported observations about their experience with Docksy that, while not enough to create common themes, are nevertheless interesting to report. A couple of participants experienced a sense of control while using Docksy.

"Docksy give you the impression of **control**, because you can change the color of the panels, or swap the files around." [P1]

"I like been able to increase and decrease the number of panel, that **control** was very helpful to me." [P20]

"The **control** over everything by user is great." [Survey]

While some participants felt in control, another felt that Docksy guided him to organize the documents.

"If the desktop would look like Docksy, they basically have to organize it. It will be cool to see people finding their way into **organizing either they recognize it or not**. Even if it looks like this, things would still be organized." [P4]

It is interesting that the above participant felt like Docksy and its panel structure induced him to organize his document, and he found the experience positive.

One participant used an interesting term for panels; he called them "active folders".

"I think workspace organizes the documents in 'Active Folders'. It's not like folders; it is active folders, the panels. Because in windows you go into a folder, and then create a subfolders, and you end up looking and it takes a while to access your files. Here you have it well organized already, to me it is a folder and I already see all the documents, I don't have to organize and do mundane things."

One participant used a panel as a place for current work. She would drag there the document she was working on from other panels, and once done with her work she would drag it back to its original panel. She said:

"Panel number 7 was my **working space**. Whatever I was working on was in this panel, and then I will move it back in its original panel."

7.4.13 Problems

As Docksy was in the first prototype stage, many features to make it more usable were not implemented yet, and a couple of bugs were fixed during the study. Some problems participants experienced were either related to usability or to lack of features that they were accustomed to with current systems. Other issues raise higher-level questions about the design of Docksy.

On the interface level the choice of colors, which was random, was uncomfortable for users. Participants liked colors, but not the strong colors that came out

randomly. Changing the number of panels was a task that some found not very intuitive. Some participants had problems in increasing or in decreasing the number of panels.

Among the missing features was the possibility to create new files directly in Docksy, and to drag files into emails or other programs once the documents were edited. One participant said that Docksy could have been useful to him only if it had thumbnails, because he wanted to manage lab and personal pictures. Another unimplemented feature was tha layout inside a panel.

On the design front, the main problem was the lack of scrolling, or of an equivalent feature to browse a large quantity of files inside a panel. This is a design feature that still needs to be explored.

One interesting problem was the difficulty to move from a Windows system, based on folders, to a system based on workspaces and panels. While one user was not able to make the transition and did not use Docksy, another made the transition but was expecting to use subpanels in the same way in which she used subfolders.

"What I liked the least was the lack of ability to import sub-folders." [Survey]

"I didn't like that it wasn't intuitive, maybe because **I am used to a different structure in MS folder**. […] I tried to organize them in my folder, so that I could bring them over Docksy, and I created subfolders, but it wouldn't let me drag the subfolders over here, I am not sure why." [P18]

The previous participant tried to organize documents in MS Windows folders before dragging them over in Docksy, instead of using Docksy to organize them. She

also would have liked to have in Docksy subpanels, similar to subfolders. She did not make the transition to Docksy during the two-week study.

One issue that hampered use of Docksy by some participants was that Docksy is a standalone program, not integrated with Windows OS and not substituting for the standard Desktop. This required them to manually start the program and have an additional program to manage, instead of having it readily available like the desktop. Docksy was developed as a standalone program because it was still a prototype, and integration with Windows OS would require a much larger effort and coordination with Microsoft. At the same time, the stand alone program gave users the possibility to rely on their traditional system and not feel threatened by the new system taking over their computer. Some participants wanted to be sure of this before agreeing to take part in the study.

7.5 Discussion

Participants in this study used Docksy for at least two weeks. While some participants used Docksy to try out its potential, without a specific goal in mind, others employed it for projects. Still others used it for activities that they would usually perform on their normal operating system desktop.

The first user study research question was "Which kind of organization do users use in Docksy?" The data collected, the name of the panels, their uses, and the interviews and surveys indicate that participants used panels to group documents belonging to subcategories, to build or highlight relationships, or to structure their

activities. The former can be seen in the case of the user using panels with names such as "data", "draft", "results", "references", "presentation", all related to subsections of a dissertation writing project [P9]. The second can be seen in the user that said that he would use panels to create logical networks among papers, and that documents in each panel are related to each other [P14]. The third can be seen in the case of the participant that used one panel for the work scheduled for the week, one for the work assigned to Monday, and one for the work done [P7]. Participant 23's [P23] use of one panel for current work, where she would drag in and out the file she was currently working on, is another example of panels' use to organize activities. Users found very useful the possibility to drag and drop HTTP addresses from the browser. In this was they could build a section of things to read or to look up when time allowed or a reference section. This preference points to another use for panels for work scheduling; in this case the papers are scheduled to be read when time allows.

Docksy's workspace was either seen as a working space, a project space, or as an archive. A user said "I don't see Docksy as a desktop, but as a library where I put documents that I gradually refer to". This also shows that Docksy has the flexibility to be used in different ways.

Besides panels, not many participants made use of the additional features in a significant way, i.e. the checkboxes, the flags, or the comments. One reason could be that the study period was limited to just a couple of weeks. Those features are likely to be more useful when working on a project for a longer period of time. Another reason could be that some users did not understand how they worked. Visually there was no

difference between the tag and the comment text fields, and some participants did not understand the difference. A third reason, that a couple of participants mentioned, is that they did not want to invest energy into building a structure that they were going to use for a limited time and that they could not transfer to their traditional environment once the study was terminated.

The second research question was "Does Docksy support organization of documents for projects?" Data shows that 59% of users used it to organize projects. It is worth to remember that at the beginning of the study I explicitly asked participant to choose at least one project to work on. While some participants actually used Docksy for projects, others used it to organize general day to day activities, and one person used it as an archive. The organization of day to day activities is still one of the onjective of Docksy. Panels were the feature most used in support of projects. Panels were used in support of projects in three ways. First, participants separated activities to be performed at different times in different panels, and therefore panels had a temporal connotation or they were used as a scheduling mechanism. For example, they assigned to different panels activities scheduled for the week or for the day. Second, they partitioned in different panels documents that referred to subcomponents of a project; for example, one panel assigned to documents for the dissertation, one for the presentation, and one for the data collection. Third, they clustered in different panels documents related to each other. For example, one panel was for papers relative to writers of the fifteenth century, and one for sixteenth century writers.

The third research question was: "What is Docksy's potential for changing user practice?" Participants adopted very quickly the panel organization, and some claimed that MS Windows had been lacking this feature for long time. Some hoped to have the panel features integrated in MS Windows. Some participants said that they see themselves as using the comment and checkbox features in the future, assuming that they would have the chance of using Docksy for a longer time.

One participant expressed very clearly one of the most important aspects of Docksy: "Before, you need to change your mindset. Docksy helps you change your mental model, the way in which you are able to organize your files. You change the way in which you think to organize your files; before, you need to change. Docksy helps you to change your reasoning, in such a way that by changing your reasoning you can change the way in which you organize."[P26]

Docksy substitutes folders with spaces, folder "boxes" with spatial panels. The mental model and the practices associated with their use change. In general people appropriate new environments and use it according to their new mental model, they develop new practices, or they form new mental models. The study suggests that users would change their practices provided they were given more time to use the program.

One participant during the interview reasoned on the way she organized files for the study and how she would do for the future, showing a change in progress between her folder structure in the traditional system, her initial use of Docksy, and her envisioned way of using it in the future.

"I will use this product for each scholarly article I am gonna use. I will divide the screen into the stages of my research project. I can put piano^3 1 for all material of my literature review, including my pdf documents and stuff. Piano 2 will be a Word doc plus other scholarly articles involving my method section, and I could store all my data and my interviews in piano 3.

Versus putting all of them in a single folder which is what I have right now.

And that is how I would use it. I would use it for each project , as oppose to what I did right now as more organizational tool." [P23]

In the second paragraph she describes her traditional organization. In the first and third how she is planning to use Docksy in the future, i.e. one workspace for each project; and that is different from how she had been using Docksy during the study, where she put together different activities. She described using Docksy like a work-oriented environment, and she was still experimenting on which organization would better fit her work.

One of the advantages of Docksy is that, although it is different from the current systems, i.e. the current desktop and the file system, it introduces a new environment that is fairly easy to transfer to and that is familiar. In this way, it does not impose a big sudden change; it affords a smooth transition. Participants can gradually move from one environment to the other, and Docksy provides scaffolding [Hogan and Pressley, 1997]. A couple of participants mentioned these aspects.

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3 Piano is Docksy name for Panel.

"I have seen people with tons of files. If the desktop would look like Docksy, they basically have to organize it. It will be cool to see people finding their way into organizing **either they recognize it or not**. Even if it looks like this [his workspace], things would still be organized." [P4]

"By using Docksy you understand the functionalities that it can offer you. Those ones that it can have for you. Then, **those functionalities that it offers me can be different from the ones it offers you**. Everyone has its own. Docksy is a **multi-domain tool, useful for its own versatility**."[P28]

Therefore Docksy offers a tool that is easy for people to appropriate and to adapt to one's own practices. At the same time it affords changing practices. This was one of the aims and challenges of the design.

8. CONCLUSIONS AND FUTURE WORK

Electronic documents are not just items to be stored and retrieved on the computer. Documents and their organization are part of a bigger work environment. Users view them as components of activities and workflows and make use of documents to structure activities. However current systems offer limited support for these practices. The traditional file system was developed mainly for storing and retrieving files. While the desktop made a big step forward in the creation of a work environment, it still offers limited support and the file system with the hierarchical folder structure remains basically unchanged.

This raised two main research questions. First, what are users' practices in structuring their work environment on the computer? Second, which kind of environment or features will support those practices? The first part of the dissertation addressed the first question (Sections 3, 4 and 5) drawing on literature and on results from a study of current practice. The second part of the dissertation addressed the second question by developing a new tool with features designed to support the practices emerging from the first study, and by studying the use of the new tool.

The introduction of a new tool in an environment for study purposes is always a challenging effort, because tools and practices coevolve. Once the new tool is introduced in the environment, the user may appropriate it by adopting it and by adapting it to his needs. A tool designed to satisfy a current need, such as the need to demarcate a project, once it is immersed in an environment may create new needs, such as the need to add

descriptions or properties for the project or the creation of a collection for all the projects. Thus, a tool designed to be used in a certain way may end up being used in another way, quite differently than how the designer was expecting. For example, the name of a file is used not only to identify the file, as was the original intention, but to add supplemental information useful to the user. The new unexpected use could offer perspectives that the designer may not have thought about. It is part of human nature to use things beyond their intended limits. Therefore the study of a new tool when it is immersed in a real environment, as opposed to a user study in the lab, is more likely to identify such appropriations.

The above concerns were taken into consideration during the design stage. Not only was it expected that people would use the tool in a different way from the intended one, but this was encouraged in the design. The aim behind Docksy's design was to create a lightweight environment, easy to use and flexible enough to be adapted to users' needs; easy and useful enough to be incorporated into users' daily practice, old or new. One way to accomplish this was to design a system whose interface expanded on the interface of the current system without giving the impression of creating a completely new program. Such a system could be used to learn about practices and their evolution.

The tool or environment developed for this dissertation, Docksy, had therefore a double purpose; the short term purpose of testing the new features and the more long term purpose of learning about user practices.

As explained in Section 5, Docksy was based on a first cycle design, and only implemented a subset of the features proposed in the initial design. Design, development

and testing are performed in a cycle. As a result the testing was limited to those features included in this initial prototype. Moreover the user study was limited in time; participants were interviewed after two to three weeks of use, and that time is too limited for people to fully adapt a new tool and to incorporate it into their practices. Nonetheless, the study showed the potential for changing user practice and the potential for the system to be adopted by users.

The following subsections discuss how the different features of Docksy supported users in their daily working practices and if they met the expectations set forth by the design.

8.1 Panels

During the preliminary study, presented in Section 4, we observed that participants that used the desktop as a workspace or as a dashboard clustered documents on the screen or used different areas of the screen for different purposes, zoning the screen. For example one user used the center of the screen for the current work, the top left corner for the things scheduled for the week, and the top right for references, such as dictionaries. To support these practices Docksy provided panels that tile the desktop, to make explicit the clustering or the screen zoning.

The results of the Docksy study support the idea that panels were useful in supporting the user practices regarding clustering or screen zoning. Panels were the feature that participants liked the most. They liked the background colors, the possibility to drag and drop documents from one panel to the other, and the possibility to title the

panels. Besides commenting on interface characteristics, participants reported that panels helped them to better focus on the work at hand, helped them to organize files, and gave them a sense of control.

The feature that users found most important for panels was the possibility to have an overview of all their documents and at the same time to categorize or cluster the files without the need to open and browse the folders.

Participants in the study also reported that panels helped them to better locate papers inside a workspace. Search versus organization and browse is a debated issue in literature [Cutrell et al., 2006, Dumais et al., 2003, Karger and Quan, 2004, Nardi and Barreau, 1997, Barreau and Nardi, 1995, Boardman and Sasse, 2004, Kelly, 2006, Nardi, 2002, Robertson et al., 1998, Voida and Mynatt, 2009, Fertig et al., 1996a, Jones et al., 2005b]. While both approaches have their merits in different circumstances, there is still another related issue: what can help the user find a file when he knows the folder containing the file and he has the folder open in front of him? One participant highlighted the problem:

"Right now I have a pdf folder and I have all of my pdfs in. But sometimes I need to categorize them, like High pressure freezing, R6, R3, R5, so that way I know this will allow me to go to the exact panel, and not have to scroll to and try to remember which author wrote which paper. So I can categorize all this as R6, which would be my title, and put all of the articles underneath that are related to it. Now I have author and date in the name of the file. And that is very difficult to remember, because I get mixed

up, and I don't remember who did what, and I have go click and open the file and that takes a long time, so this will make me more efficient." [P20]

The problem is not only to locate a file in a folder, but also to remember or reconstruct the title of the file, or the content.

Participants, both in our preliminary study and in the Docksy study, often mentioned the problem of locating documents inside a folder. They knew the folder or the parent folder containing the file they were looking for, but they complained that it took too long to locate the document inside it. Either there were too many files in the folder they were looking for, or they did not know in which subfolder they placed it, and they spent too much time clicking and browsing the different subfolders. The preliminary study shows that participants tackled the problem by using a variety of methods. One of the methods was to modify the title of the file in order to force a certain sorting. For example users would add a date at the beginning of the file name, so that alphabetically sorting would put the file in a position they would find easily; or they would employ sorting by modified date. Some participants modified the icons of the most used files or folder to help locating them. Docksy provided another way to deal with this problem: panels. Participants in the Docksy study reported that they used panels to subdivide documents inside a workspace that was equated to a big directory. Subgrouping documents inside panels helped reduce their number in a particular group being examined, and therefore speed up the location, while also leaving them all visible at the same time instead of obscuring them inside a closed folder. Moreover panel color and spatial position of panels inside the workspace added contextual information that

helped to speed up the location of files. Participants reported that the tag feature also helped them in locating files. A participant said that to put a document into a panel was equivalent for him to tag it with a label. Panels turned out to be a simple solution for helping users employ multiple strategies to locate documents inside a workspace.

Panels also offered support for incremental formalization. Each panel was created with a default name that the participant was free to change. The titling of the panels was not mandatory, giving users the possibility of deferring the formalization of their task or work. Not all users named the panels. One participant said:

"I didn't put the names on the panels because I just forgot, I got so comfortable with it, I could look right at piano[4] 2 and I immediately know what it is, it doesn't even need a name. It is so visible that I knew it. It never even crossed my mind to put a name." [P18]

Forcing formalization adds overhead that may discourage people or force them to overcommit too soon. Shipman and Marshall [Shipman and Marshall, 1999] reported about the unwillingness or inability of users to make structure or content explicit, and discussed how users reject or circumvent formalisms. Panels provide a way for users to structure a workspace without imposing users to formalize it. Placing documents in different panels without forcing the selection of a title helps users create a structure without requiring too much from them. Also, the structure is not too rigid; even if documents are in different panels, they still are all visible and next to each other, and moving files from one panel to another is very simple.

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4 Piano is Docksy name for Panel.

The preliminary study described participants using a variety of different temporary files. The Docksy study showed that participants used some panels to place categories of temporary files. For example, some users delegated a panel for documents which they were planning to read, with a panel title such as "To Read", or they created a panel for references that they needed for a current task, or they used a panel for activities to do at a scheduled time, like on Monday. Once the task relative to those documents was accomplished, the file was either deleted or moved to another panel. This suggests that panels were also appropriated as support for managing temporary files.

Docksy's panels also proposed a nonhierarchical solution as opposed to the folder structure. However scaling issues still must be explored.

Overall, the results from the final study suggest that the Docksy workspace, structured in panels, provided support to the users' practices, and in particular for zoning the screen or clustering documents, for locating files inside a workspace, and for managing temporary files; moreover Docksy afforded incremental formalization.

8.2 Comments, Labels, and Flags

The preliminary study showed that people used a variety of strategies to organize their work. Besides positioning documents in particular places on the screen or in the folder structure, they also used colors to distinguish particular icons, they used note files inside folders, and they used the file title to add information regarding the document. For example users added the version name to the file, or the names of the people who modified the file, or some other description word such as "draft" or "final". To support

those practices Docksy featured comments, tags, and checkboxes or flags to add to the representations or icons of documents.

The Docksy study suggests that those features were useful in structuring users' activities. Only a limited number of participants used tags, comments and checkboxes, but many participants who did not use them saw themselves as using those features in the future, provided that they would have more time to work with Docksy instead of just two weeks, and provided they would feel that their effort will not be wasted at the end of the study.

Participants who used tags, comments, and checkboxes used them to prioritize their work, to add information about the status of the documents, to add information about operations to do with the documents, to add information about the content of the file in order to avoid opening it every time they considered it, and to help locate the file. One participant added a number in the tag to prioritize files. Another user said:

"I like the comment thing, if there is a volume of files, I like the fact that you can write stuff down for each file, and what you did, and what you edited, and things of that nature. So I think in terms of organization that is important, because sometimes when I edit, what I do I create a new folder for things that have been edited and I will put the edited ones in the edited folders, where here I just put a comment that it has been edited, or use a checkbox. I just find writing it is easier." [P21]

This suggests that Docksy was useful in supporting users to structure their work, and in using the documents as explicit items in the workflow description.

8.3 How to Support Practices?

The main goal of this dissertation was to study how people organize their documents when working on tasks or projects, and to explore which features support users in this process. The previous subsections commented on the impact of Docksy's panels, comments, tags, and flags or checkboxes on user practices.

These new ways of organizing documents are in support of work organization. This would suggest that Docksy was not only supportive in user practices, but also that the support was related to the use of documents to structure the work organization and the workflow.

Overall, the studies, both the preliminary study and the Docksy study, suggested that an important aspect of organizing files for current tasks or projects is the possibility to have an overview of the workspace. The studies also suggest that participants value the possibility to categorize documents or to segment them in a variety of ways, including explicit spatial arrangement and by adding colors. They also valued the possibility of adding information to documents, both in textual form and in other forms such as checkboxes or colors.

Providing an overview of all information is important in many contexts; information visualization is a broad research area. Various techniques have been researched to visualize groups of files [Dourish et al., 1999, Furnas and Rauch, 1998, Lepouras et al., 2008, Robertson et al., 1998, Card et al., 1996], or textual and link information [Shipman et al., 2004, Shipman et al., 2001, Marshall and Shipman III, 1995]. Hierarchical structures, spatial structures, 3D visualization, all offer support for

visualizing information; they offer mechanisms for creating overviews of the totality of information and for segmenting them, or for browsing them and retrieving them. Participants in the Docksy study were previously using the desktop and the folder structure to organize their documents. After using Docksy, they expressed their appreciation for the possibility to have an overview and a way to classify their documents different than the one offered by the desktop and folders. They found the mechanism offered by Docksy useful in providing an overview and segmentation at the same time.

8.4 Changing Practices

One of the main goals of the dissertation was to determine how Docksy changes users' practices. The results of the study suggest that Docksy has the potential for changing users' practices. One participant employed in Docksy a type of organization for her documents different from the one she employed in her file system; she reasoned about the way she would change her organization:

"I will divide the screen into the stages of my research project.

Versus putting all of them in a single folder which is what I have right now. […]

And that is how I would use it. I would use it for each project, as oppose to what I did right now as more organizational tool." [P23]

Other participants employed an organization of documents different from what they did in the past. For example, one user created one panel for the work scheduled for the week, one for Monday, one for "done" and so one. The participant [P21], quoted at

the end of the last subsection, used comments and checkboxes instead of putting documents in folders. Yet another participant used tags to add a priority to documents, to indicate the sequence in which he wanted to read the documents.

A longer study would be able to give more insight into users' changing practices; however the above cases suggest a direction in which the practices may be changing, and overall they suggest that Docksy has the potential for changing practices.

8.5 Contributions

This dissertation made two main contributions:

- It generated a better understanding of the issues and practices regarding the organization of documents in support of activities.

- It provided a design of an environment to organize information based on an activity paradigm as opposed to an archiving paradigm and delivered the instantiation and evaluation of a system based on such a design.

8.6 Future Work

Future work is along two lines. One is the continuation of the cycle of implementation and user studies of Docksy. The other is the exploration of new hypotheses or research questions generated by previous studies.

Docksy implemented a subset of the features proposed in the design. Future work includes the implementation of the full design. The design itself needs to be subjected to revisions first, following the results of the Docksy study. In the ultimate vision, Docksy

should also be integrated in the OS and substituted for the standard desktop. This would allow having longer user studies and provide more insight into the use of the checkbox and comment features, and insight into the evolution of user practices.

The results of the studies presented in this dissertation suggest a few themes or new research questions worth of exploration. One theme is related to the use of panels as explicit clustering tool. The results of the dissertation indicate that users liked panels. This generates the research question: "Is explicit clustering by using paneling, such as those provided by Docksy, preferable to unsupported clustering or spatial arrangement on the desktop?" It also opens the question of the exploration and comparison of alternative clustering or categorization tools. An alternative solution to a hierarchical structure is the use of hypertexts and spatial hypertexts and in particular the use of collections in spatial hypertexts [Bernstein, 2003, Shipman et al., 2004, Shipman et al., 2001, Shipman, 2001]. A comparison among the various techniques and the practices that they generate is another research area to explore.

A related research issue is whether and how the implementation of the panel feature affects its use. The current Docksy implementation allows copying a panel from one workspace to another using a menu. Would more direct panel mobility change how participants use this capability? Would more or less restrictions on its size or constraints change use? Would how the implementation maps to the file system change its use? Would a different integration with text change its use?

Yet another research topic is related to the type of paneling. Docksy proposed paneling based on a grid in which every panel in the same column has the same width,

and every panel in the same row has the same height. One future development would be to experiment with alternative arrangements and different shapes.

Screen size and its relationship to panel size and panel number is another topic to explore. Similarly is the use of panels in very small screen. Or the relationship between screen size and number of documents placed inside it.

Another research issue worthy of exploration is the use of a scrolling or other mechanism to browse a large amount of documents in a panel, thus avoiding a hierarchical structure.

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APPENDIX A

DEMOGRAPHICS AND DOMAIN SURVEY

Using Docksy to Organize Documents

Subject ID: _____

Please fill in a value(s) or circle your response.

1. Age: [ ] 18-24   [ ] 25-29   [ ] 30-34   [ ] 35+

2. Gender: Male / Female (circle appropriate)

3. Classification: Undergraduate / Masters / Doctoral / Staff / Faculty / (circle appropriate)

   other ………………….. (please specify)

4. I use a computer

   a. ☐   less than 1 hour a week

   b. ☐   1 to 5 hours a week

   c. ☐   5 to 20 hours a week

   d. ☐   more than 20 hours a week

5. I have used computers regularly for

   a. ☐   less than two years

   b. ☐   more than 2 year and less than 5

   c. ☐   more than 5 years and less than 10

   d. ☐   more than 10 years

APPENDIX B

FINAL STUDY: SURVEY

Using Docksy to Organize Documents

Subject ID: _____	Strongly Agree	Agree	Neither Agree Or Disagree	Disagree	Strongly Disagree
Docksy was easy to use	☐	☐	☐	☐	☐
I found the Checkboxes/Flags feature useful	☐	☐	☐	☐	☐
I found the Tag feature useful	☐	☐	☐	☐	☐
I found the Comment feature useful	☐	☐	☐	☐	☐
I like the layout of the document features	☐	☐	☐	☐	☐
Using the new features was easy (check boxes, tags, documents)	☐	☐	☐	☐	☐
I will like to use those features in the future	☐	☐	☐	☐	☐
I found the background grid useful	☐	☐	☐	☐	☐
The grid was easy to use	☐	☐	☐	☐	☐

1. How will this tool change the way you work with documents?

   ....

2. What did you like of this tool?

   ....

3. Which feature did you like best?

   ....

4. Which feature did you like the least?

   ....

5. What would you like to have different?

   ....

6. Which kind of task did you use the new features for?

   ....

7. Other comments information?

   ....

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