

In Support of External Representations for Personal Information Management

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ABSTRACT

This article describes research that looks at how structure is now used and might be better used in support of personal information management (PIM). Efforts to structure personal information find expression in various external representations (ERs) such as folder hierarchies, physical piles and analogous groupings of items on a computer desktop, user-assigned property/value combinations, annotations, file and folder names including leading characters, etc. But the ways in which these ERs develop over time and the roles they play in the management of personal information are poorly understood and poorly supported.

Fieldwork is described that identifies several opportunities for improved support of ERs to manage personal information. A Project Planner prototype supports a rich-text outline view for the creation of ERs (project plans). Project plans can be used not only to represent the structure of a project but also to organize information (electronic documents, email messages, web pages) required to complete the project. The Project Planner works by extending, rather than trying to replace, the user's current file folder structure. The Planner works as an extension to the file manager to provide people with rich-text overlays to their information.

Categories and Subject Descriptors

H.5.2. [Information Interfaces and Representation (HCI)]: User Interfaces—Evaluation/methodology; —User-centered design

General Terms

Human Factors

Keywords

Personal information management, human-computer interaction.

1. INTRODUCTION

As people collect information, they structure it – in various ways and to varying degree. People create physical piles and analogous groupings of items on a computer desktop. People order their information. People may assign property/value combinations, annotations, and file and folder names including leading characters to influence ordering. People create folder hierarchies.

This article describes research into the structures that people impose (or attempt to impose) on the information they collect. What structures do people create? How are these structures used? ... towards what ends? And what tool support might be useful?

Research described is in two parts that stand in complementary relationship to one another:

1. A fieldwork study and a follow-on survey provide descriptive data concerning how people currently create and use folders.
2. The analysis of fieldwork data has driven prototype development that explores ways to help people structure their information. Prototype work

The prototyping work explores the possibility that better support for the creation, use and re-use of structure can yield richer external representations (ERs) that serve several purposes through a single effort: *The ER that summarizes and helps people to understand their information can also help to integrate and organize this information for effective use at the right time and place.*

2. BACKGROUND AND RELATED WORK

The research is part of a larger effort in the Keeping Found Things Found (KFTF) project [12, 13, 28-31, 33] to study personal information management or PIM. PIM includes a range of activities that we, as individuals, perform to acquire, organize, maintain and retrieve information for use in our daily lives.

The research places special focus on the uses of folder hierarchy and folder naming in the structuring of personal information. Folder hierarchies persist notwithstanding the many problems and limitations associated with their use (e.g., [9, 10, 19, 39]).

What purpose do folders serve? To be sure, folders group information items so that their location, access permissions, storage and other resources can be managed. To be sure, folders organize information so that it can be found again later on (and they sometimes hide this information as well).

Our own fieldwork suggests that re-access to personal information is not necessarily the sole or even the primary purpose of a folder structure [33]. Folder structure for a project can represent, for example, a kind of problem decomposition, albeit partial and incomplete.

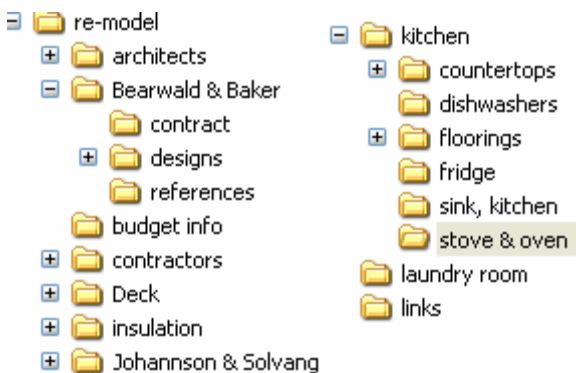


Figure 1. A file folder hierarchy for a home re-model.¹

The structure in Figure 1 provides, in one view, many of the key components of the re-model. The hierarchy contains, intermingled, a record of tasks completed, decisions made and a reminder of tasks and decisions still to be addressed. This structure is, therefore, an important aid in the fundamentally difficult activity of anticipating information need [11]. Of course the folder hierarchy is no crystal ball into the future. But it does provide a reasonably concise representation of the likely information need.

Structures such as that illustrated in Figure 1 are typically not created all at once. Instead, these emerge over time as more and more information arrives and as a person's understanding of this information evolves [33]. The development of a folder hierarchy can be seen to occur as part of an effort in *sensemaking* [18], i.e., in efforts to make sense of the information.

¹ The view in Figure 1 has been re-formatted from the "Explorer Bar" folder view of the Windows Explorer and with identifying information altered.

Russell et al. [45] provide an excellent analysis in which structures (representations) are acquired and discarded depending upon a perception of costs – the costs to stay with a current structure vs. the costs to switch to a new structure. As a human activity, sensemaking and the search for structures involves both Internal Representations (IRs) and External Representations (ERs) which combine to form an integrated cognitive system [27, 35]. As such the hierarchy itself plays an essential role in completing the re-modeling task [37]. Enhanced support for the creation and use of ERs, hierarchical and otherwise, may provide a way to deal with *information fragmentation*, a major problem current with PIM.

2.1 Information Fragmentation

A wide range of tools and technologies are now available for the management of personal information. (For recent reviews see [8, 22, 44]). But this diversity has become part of the problem leading to *information fragmentation*. A person may maintain several separate, roughly comparable but inevitably inconsistent, organizational schemes for electronic documents, paper documents, email messages and web references. The number of organizational schemes may increase if a person has different email accounts, uses separate computers for home and work, uses a PDA or a smart phone or uses any of a bewildering number of special-purpose PIM tools. New tools often introduce still more schemes of organization. A report on PIM [32] from the 2003 Information and Data Management (IDM) workshop identifies information fragmentation as one of the major challenges that must be met if the above-listed benefits of better PIM are to be realized. Problems of information fragmentation are encountered at several stages in PIM:

1. *Keeping new information.* When useful information is encountered, people may not know how and where to keep it or even whether it is necessary to do so. (Is the information already "in here"?)
2. *Maintaining existing information.* The costs and difficulties in maintaining an organizational scheme may be multiplied by the number of forms for which some organization is necessary.
3. *Re-finding information.* Where to look?
4. *Remembering to look.* When information is scattered in several different organizations, the reminding value of each organization is diminished. Even if people know where to look for a file, email message or web reference, this does them little good if they forget to look.
5. *The assembly of task-relevant information.* Even when a person remembers to look and knows where to look, considerable time may be required to retrieve task-relevant information from different places and across several different information forms (email, e-documents, web references, paper).
6. *Do I have the right version?* The same information may be stored several times. This is especially likely when people adopt a "keep everything" (just in case) approach and cannot remember for sure whether they already have the information. Determining which of several versions is the current or correct version can be extremely time-consuming and error-prone.

A report on PIM [32] from the 2003 Information and Data Management (IDM) workshop identifies information

fragmentation as one of the major challenges that must be met if PIM is to improve. Moreover, the study of PIM itself is often fragmented according to applications in ways that parallel the fragmentation of personal information. Many excellent studies focus on uses of and possible improvements to email (for example, [2, 5-7, 21, 24-26, 38, 51, 52]). Other studies similarly focus on the use of the Web or specific web facilities such as the use of bookmarks or history information (for example, [1, 14, 17, 46, 47]) . A wide range of studies have looked at the organization and retrieval of documents in paper and electronic form (for example, [15, 16, 39, 50]).

2.2 Bring the Pieces Together Again

In response to the problem of information fragmentation, several important prototyping efforts offer various kinds of unification. These efforts include LifeStreams [23], PRESTO/Placeless Documents [19, 20], Haystack [43] and UMEA [34]. UMEA advances the “project” as one means to bring together various forms of information – electronic documents, email-messages, web references. However, the project in UMEA has no internal structure.

LifeStreams was one of the first efforts at a unification of information that could take us beyond the “desktop metaphor”. The essence of LifeStreams is that documents, other information items and memorable events in a person’s life are all placed in a single time-ordered “stream”. LifeStreams is beautiful in the elegance and simplicity of its data model. However, LifeStreams does not well accommodate the kind of hierarchical, problem decomposition seen in project planning [33].

PRESTO/Placeless Documents advances the notion that a folder hierarchy is limited, antiquated and should be abandoned outright in favor of a property-based system of filing and retrieval. However, faceted classification, which is roughly equivalent, can be quite problematic to implement [4, 41, 49] and requires a great deal of understanding of the information so organized. It may be fine for special collections like recipes, but not so good for new project-related information – especially when little is known about the underlying properties of the information aside from the information’s potential relevance to the project.

Haystack pursues an underlying unifying data model. The proposed research direction is potentially complementary to efforts like Haystack. Requirements that are identified could point more concretely to the advantages for Haystack’s attempted data-level unification.

It can be expected that some forms of integration will be accomplished as documents and other information items acquire increasing amounts of metadata. That still leaves a number of kinds of metadata, most notably intended use [36], that, under most circumstances, only the user can provide. Observational data also suggest that people continue to have a strong preference for location-based finding, orienteering or, simply, browsing as a primary means to return to their personal information [3, 40, 42, 48].

Several researchers have explored possible expansions of email applications as a path towards integration – mostly notably

integration involving task management [6, 21, 24, 25, 38, 51]). And yet there is ample anecdotal evidence to suggest that many people routinely “turn off” email precisely in order to get tasks done.

3. FIELDWORK AND SURVEY

Initial results from the fieldwork study have been presented elsewhere [33]. Here we report a more detailed analysis of these results and we also report the results of a follow-on survey.

Fourteen participants (six women, eight men) each completed a session of 60 to 90 minutes in length which concluded with the question “Suppose that you could find your personal information using a simple search rather than your current folders...Can we take away your folders? Why or why not?” Participants were permitted to stipulate additional features of this hypothetical search utility and the “folder-free” situation. Issues of control and storage would be handled in some other way. The search utility itself would be fast, effortless to maintain, secure and private (no personal information would be communicated to the Web), etc. With these conditions in place, 13 of 14 participants gave a resounding “No!” to the question “Can we take your folders away?” (One participant gave a conditional “yes” if all his information could be ordered by date and time). In a series of informal surveys involving over 200 people, 95% of all respondents similarly said “No”.

Participants would not give up their folders for a range of reasons including:

- “I want to be sure all the files I need are in one place”.
- “Folders help me see the relationship between things”.
- “Folders remind me what needs to be done”.
- “Folders help me to see what I have and don’t have”.
- “I use empty folders for information I still need to get.”
- “Putting things into folders helps me to understand the information better”.

These reasons can be understood with reference to Figure 3. The comments of participants make it clear that the file folder hierarchies such as that of Figure 3 are more than a means to one end – the organization of files within for later access. The hierarchy can be seen as an ER, albeit partial and imperfect, for the participant’s project to re-model her house.

The participant’s file manager² was never designed to support the use of a folder hierarchy as an ER. Here are but a few of the many features that aren’t currently supported but that might be useful:

- *A manual ordering of folders.* Many participants forced an ordering of folders through the selection of leading characters in folder names (e.g., “1”, “2”, “_”, “zz”). See, for example, Figure 2.
- *The ability to use and re-use structures.* Many of life’s activities share similar structures. One business trip is much like another, for example, with a need to complete many of the same kinds of tasks (make plane reservations, make hotel reservations, ...). One participant in the study

² The participant used the Microsoft Windows XP operating system.

created special dummy folder hierarchy called “course xx_xxx” containing a structure of empty subfolders for “reading”, “assignments”, “grading criteria”, etc. (See Figure 3). There is little system support current for the location and re-use of structure.

- *Support for “garbage collection”.* All participants made remarks such as “I really need to get rid of this” or “This is in the wrong place.” Boardman and Sasse [9] report a similar finding. Several people felt compelled to interrupt the interview in order to move or delete information.
- *Other project- and task-related features.* All participants kept project folders. A project folder was defined 1. to have a name that, by participant agreement, signified a project they wished to complete and 2. to contain subfolders, the majority of which represented, also by participant agreement, either sub-projects or tasks (e.g., “(select) architect”. Useful project-related features include an ability to take informal notes and to set reminders and due dates.

Data from the fieldwork study are summarized in Table 1.

Table 1. A summary of fieldwork data.

Observation	n	%
Leading characters to re-order	8	57%
Efforts to re-use folder structure	5	36%
"I really need to move/delete"	14	100%
"Wait while I move/delete"	3	21%
Project folders (e.g., “re-model”)	14	100%

A challenge is to find the right kind of support for ERs and then not *too* much support. Support should enable, not constrain. ERs should change easily to match changes in a person’s needs and understanding.

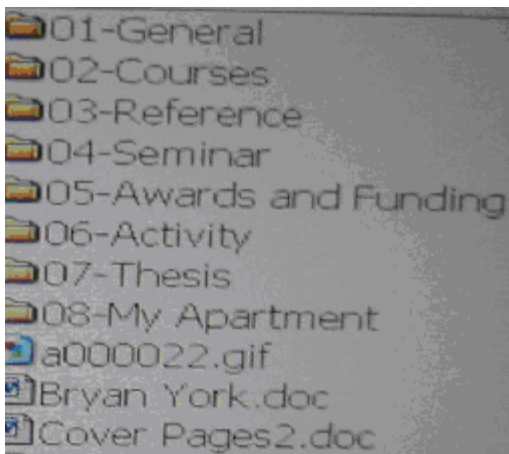


Figure 2. The use of leading characters to force an ordering of folders.

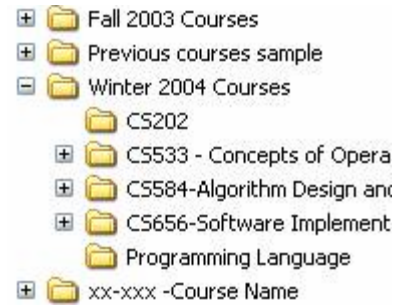


Figure 3. “xx-xxx-Course name” to re-use structure.

We draw the following implications for tool support:

- Do NOT introduce new forms of organization unless old forms can be retired with absolute certainty. However, people appear extremely reluctant to abandon the work in which they have already invested – esp. in their file folder hierarchy.
- DO, instead, enhance an existing organization. For most people, this is the file folder hierarchy.
- DO support better integration of existing information forms.
- DO support reminding and informal notes to establish “why/what” for kept information.
- DO make it possible to order “things” (e.g., folders, information items).
- DO support the re-use of folder structure; consider supporting the import of structures others have developed.
- DO consider a mechanism of in-place “auto-archiving” to remove old folders and information items that are no longer being used. Archiving “in-place” preserves the context of containing folders.

4. THE PROTOTYPE

Initial prototyping work, as guided by fieldwork results, focused on the creation of a *Project Planner* to provide an integrative, rich-text outline overlay to files, email messages and web information.

✦ Budgets

- [initial budget \(excel\)](#)

✦ Kitchen

✦ *fridge*

- freezer on side or on bottom...

▫ *sink*

✦ *stove & oven*

- ✦ ask sally and ed were they gc

- [Hi gyyys, we had some que](#)
-

▫ *floorings*

▫ *dishwashers*

✦ *countertops*

- ✦ granite

- [www.doityourselfgranite...](#)

- great site.

Figure 4. A Planner outline view of the house re-model.

The Planner's use is illustrated in Figure 4 with respect to the house re-model example. Essentially, the Planner provides support for creating and viewing an outline that is very similar to that of a word processor like Microsoft Word. A person using the Planner is able to type in her thoughts free-hand, making edits along the way as needed.

Work on the Planner prototype is driven by the following essential insights from fieldwork study:

- People seek to structure their understanding of projects they need to complete.
- Sometimes this structure is expressed in external representations (ERs) including outlines and to-do lists written on paper or in an electronic document.
- This same ER can form the basis for an integrative organization of various information items (e-documents, email messages, web information) that are needed to complete various parts of the project.

The Planner provides the following features:

- Support for a **“drag & link”** action of excerpting. It is possible to select text of interest, drag (or copy) and then drop (or paste) into a project plan. A link to the source of the drag (or copy) is automatically created. This is a way of “having our cake and eating it”. Often we are mainly interested in only a small part – sometimes only a phrase or sentence – of the email message, web page, report, article or other document that we are reading but we might like to get back to the rest of the information item later on. In the Planner, excerpting creates a link to the source.
- Support for **“create & link”**. A link to the newly created information item (e-document, email message) is automatically in at the insertion point in a project plan.
- Ordering of elements. Users can order headings, subheadings and links of a project plan however they like. People depend on ordering as a way to establish priorities and to direct their attention to “first things first”. The Windows Explorer does not support the ordering of folders and files; the Planner does.
- Notes. Users can include notes just as they would in a document. Notes can, for example, be used to provide clarification for an associated heading..

Most important, the outline structure created provides a basis for the organization of information that is needed to complete the project. For example, headings and subheadings of the outline are mirrored by folders and subfolders in the file system as illustrated in Figure 5. Hyperlinks in the plan are mirrored by shortcuts in the file system.

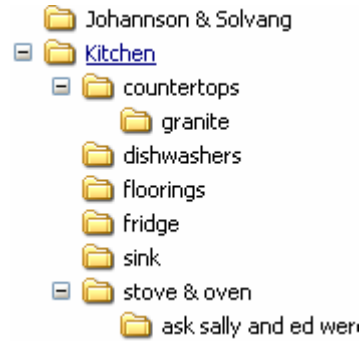


Figure 5. Work in the Planner is mirrored in the file system.

4.1 Planner Architecture

Behind the scenes, the Planner is able to support its more document-like outline view by distributing XML fragments one per file folder. A sample portion of a fragment is displayed in Figure 6.

```
<?xml version="1.0" encoding="utf-8"?>
<Label>
  <ChildLabel GUID="d64..." Name="A" Order="0" />
  <ChildLabel GUID="1ff..." Name="B" Order="1" />
  <Link GUID="5da..." Name="My Work" Order="2" Li
  <Note GUID="103..." Name="Here is the text for
  <Word GUID="ad7..." Name="Word Doc" Order="4" L
  <ChildLabel GUID="e82..." Name="D" Order="3" />
  <ChildLabel GUID="1c0..." Name="E" Order="5" />
</Label>
```

Figure 6. A sample XML hidden file used to support a rich-text overlay to the file system.

For any given folder, the Planner assembles fragments on demand to present a coherent project plan view including notes, excerpts, links and an ordering of subfolders (and sub-subfolders).

The distribution of XML fragments in association with file folders has more general application as a way to support a variety of views into a collection of personal information. Other potentially useful views include work flow views, decision tree views and tabular views. Views can readily be enhanced through the use of pictures and graphics.

4.2 A Table View

Clearly, information does not always fit well into a hierarchy. For example, a teacher working with the information in Figure 7 may sometimes want to view submissions for Assignment 1 across all students. This is not easy to do using standard file management views.

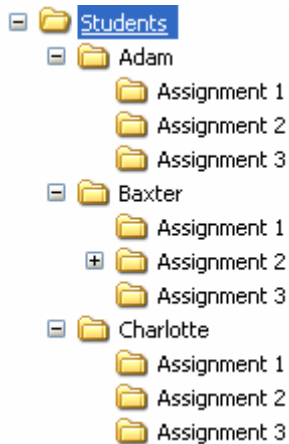


Figure 7. A hierarchy reflecting a factorial combination of properties

However, the Planner architecture makes it easy to add new views such as the table view of Figure 8.

	Assignment 1	Assignment 2
Adam	my first assignment (Word Doc) <i>nice!y done!</i> Feedback on assignment one (Email)	
Baxter	Presentation (PPT) from Baxter, my final write-up will be a few days later...(Email)	
Charlotte		

Figure 8. A table view for files and folders.

5. NEXT STEPS

Our programming effort is currently focused on a version of the Planner that works as a plug-in to the file manager (currently, Microsoft Windows Explorer). Farther down the road, we would like to complete work on a “Drag & Link” that automatically links from excerpt to source in the way that the copy & paste currently does.

We are also exploring the potential of downloadable Organizers” for various activities such as “Buy a house” or “Get a (better) job”. Organizers are a modifiable “canned plan” that people can use as a starting point. Labels/headings of an organizer can help people to approach a project and to remind them of important aspects to the project. Links in an organizer can point to useful reference information.

The *Planner* may take us one step further in integration – towards a situation in which personal information is naturally organized and managed as an outgrowth of a person’s efforts to plan a project.

6. CONCLUSIONS

The Planner currently provides a rich-text overview for any selected folder hierarchy which looks much like the outline view of Microsoft Word. A hierarchy of folders appears as a hierarchy of headings. The view enables users to work with a folder hierarchy just as they would work with an outline: As headings are added, moved or deleted, corresponding changes are made to the folder hierarchy – the Planner is simply another

view into the file folder hierarchy. But the Planner also provides document-like features not available in a standard file manager:

- Support for a “drag & link” action of excerpting. It is possible to select text of interest, drag (or copy) and then drop (or paste) into a project plan. A link to the source of the drag (or copy) is automatically created. Often we are mainly interested in only a small part – a name, number or phrase – of the email message, web page, or e-document that we are reading. But we might like to return to the rest of the information item later on.
- Support for “create & link”. A link to the newly created information item (e-document, email message) is automatically created at the insertion point in a project plan.
- Ordering of elements. Users can order headings, subheadings and links of a project plan however they like. People depend on ordering as a way to establish priorities and to direct their attention to “first things first”.
- Notes. Users can include notes just as they would in a document. Notes can, for example, be used to provide clarification for an associated heading.

Behind the scenes, the Planner is able to support its more document-like outline view by distributing XML fragments as hidden files, one per file folder, which contain information concerning notes, links and ordering for the folder. The Planner assembles fragments on demand to present a coherent project plan view including notes, excerpts, links and an ordering of subfolders (and sub-subfolders).

The distribution of XML fragments in association with file folders has more general application as a way to support a variety of views into a collection of personal information. Other potentially useful views include workflow views, decision tree views and tabular views. Views can readily be enhanced through the use of pictures and graphics. No matter how many extra views are supported, there is a single structure of folders and shortcuts underneath. This structure is now used in many ways. The structure is used not only to organize e-documents and files but also to organize email messages and web pages.

7. ACKNOWLEDGMENTS

This material is based on work supported by the National Science Foundation (#0097855).

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