

# “For Telling” the Present: Using the Delphi Method to Understand Personal Information Management Practices

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## ABSTRACT

Researchers have been studying personal information management (PIM) for many years, but little exists by way of practical advice for how individuals should manage their own information. We employed the Delphi Method to engage PIM researchers with expertise in a variety of relevant areas in a five-round extended dialog about PIM practices. Participants identified key everyday choices of PIM, suggested alternatives, and identified pros and cons of each alternative. Our contributions include: 1) a set of 36 PIM practices, along with pros, cons, and recommendations for or against each practice, 2) directions of future research and development including “near-future” improvements in tool support and 3) a detailed description of how we applied the Delphi Method to study PIM and how it might be used more widely in HCI research as a complement to more established methods of inquiry.

## Author Keywords

Personal information management; PIM; Delphi Method.

## ACM Classification Keywords

H.5.m. Info. interfaces and presentation (e.g., HCI): Misc.

## INTRODUCTION

In many human endeavors practice proceeds of necessity, only occasionally to be informed and improved by principles elucidated from formal study. Such is true for personal information management (PIM), which is defined to be “the practice and the study of the activities people perform to acquire, organize, maintain, retrieve, use, and control the distribution of information items such as documents (paper-

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CHI 2015, April 18 - 23, 2015, Seoul, Republic of Korea  
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<http://dx.doi.org/10.1145/2702123.2702523>

based and digital), webpages, and email messages for everyday use...” [16]. The phrase itself was coined less than 30 years ago [19], but people have been practicing PIM since ancient times. Logs, journals, ledgers, marginalia – even the proverbial string tied around the finger – are examples of PIM activity.

Though the practice of PIM is ancient, its importance has dramatically increased in modern times as, ever more so, the content of our perceptions and actions is mediated by information in one form or another. Frequent discussions of information overload, personal cloud-based storage, time and task management, privacy, security, etc. are testament to the practical importance of PIM in our daily lives.

Research has increased our understanding of how people manage information and the problems they encounter as they do. But each individual study is necessarily limited in scope and can only assess a small subset of the many situations of PIM activity and tool use that occur in the wild. As a result, few specific guidelines for the everyday practice of PIM have emerged from formal study. In this paper, we fill this gap using an application of the iterative Delphi Method [13, 20, 21, 23, 29]. Rather than studying people’s PIM behavior, we study a different kind of participant: researchers who themselves study people in their daily practices of PIM. Drawing upon direct experience and observation across many studies, our participants considered:

1. Which of the many everyday practices of PIM had sufficient usage to warrant closer examination?
2. What considerations, costs, and benefits apply to each practice?
3. Which practices should be recommended or discouraged for information workers given reasonable assumptions about current tool support?

Our work makes several specific contributions:

- Using the Delphi Method, we identify a set of 36 PIM practices related to the capture and retention of personal information, how to find and organize personal information, task management, and the control for versions,

clutter and fragmentation. For each practice we list relevant pros and cons and provide a recommendation for or against it. These practices and recommendations have immediate practical use for individuals and organizations to inform their day-to-day information management needs.

- We suggest directions for future research and development derived from outcomes of the Delphi Method. Many of the recommended PIM practices reflect work-around use of existing tools and so point to low hanging fruit for tool improvement. Additionally, practices where consensus was not achieved via the Delphi process point to areas where limited resources available for empirical research might be most fruitfully applied.
- We present details of an application of the Delphi Method and show how it can be used as a tool for human-computer interaction (HCI) research. We show how the method can be used to identify common user behaviors and practices in a domain (e.g., PIM). Where there is an achievable consensus among domain experts (e.g., PIM researchers), the Delphi Method provides an effective means to reach this consensus. And where not, the method makes explicit the reasons why not.

Just as the oracle at the eponymous site of ancient Greek civilization was used to foretell the future, the Delphi Method is a valuable way to achieve consensus among experts concerning likely futures in a given area such as HCI. However, the approach's consensus building process has broader application. It can, for example, be used to gather perspectives on past events or, as is the case for the work described in this paper, "for telling" a current situation of PIM practices. After a discussion of related work, we describe in detail how the Delphi Method was applied to study PIM, the practices that emerged from this process and wider applications of Delphi Method in the general study of HCI.

## RELATED WORK

### Personal Information Management

Previous research has explored PIM practices by looking at end-user behavior. These studies have shown that individuals differ dramatically in their tendencies to organize [10, 28]. For example, studies report a strong preference for navigation over search as the primary method for the return to personal files that endures notwithstanding the improvements in desktop search [1, 5, 24]. However, people are increasingly disinclined to invest in the organization of emails into folders for use in navigation [27], opting instead to use search as a primary method of return to email [17].

People keep their personal information in a wide variety of ways and according to best guesses of later use [11, 18], and tend to organize digital information by project [10]. Notwithstanding organizational efforts however, fragmentation of information, by tool and device, is a major concern [4, 14]. People often eschew the expressive freedom and flexibility of tags in favor of the familiarity and, we might

say, universality of folders [6, 12]. Similarly, people often prefer to manage tasks and to-dos in an ad hoc manner using another universal form of information in our digital age – email [2, 3].

Some of these PIM studies have resulted in practical implications for people's everyday practices. For example, for efficient retrieval, people should keep fewer than 22 items in a folder [8] and use the icon view rather than the details view [9]. However, existing formal research addresses only a fraction of the choices people face in everyday PIM.

The work presented in this paper complements traditional PIM research by bringing together many of the researchers involved in these studies with the intent of being prescriptive concerning a broad range of everyday PIM practices. Through formal study and self-reflection, researchers acquire considerable practical knowledge concerning practices of PIM. The goal of our work is to enumerate these practices, and identify which are successful and which should be avoided given a particular user and circumstance. Codifying this knowledge has considerable practical value and offers a useful point of departure for additional study, especially into areas where researchers have not yet achieved consensus. Moreover, practices that work in spite of current tool support can carry implications for low hanging fruit that can be addressed with the next-generation of PIM tools.

### The Delphi Method

We employ the *Delphi Method* [13, 20, 21, 23, 29], a widely-used process for achieving consensus. Noting the method's potential application to the study of human-computer interaction, Mankoff et al. describe it as a means of "collecting the views of people (typically, experts) through iterative dialog" [22]. The Delphi Method has been favorably contrasted with the use of focus groups. Rowe and Wright, for example, characterize the method as a way "to allow access to the positive attributes of interacting groups (knowledge from a variety of sources, creative synthesis, etc.) while pre-empting their negative aspects" [23].

The Delphi Method is perhaps most accurately regarded as an approach rather than a well-defined procedure. Although Linstone and Turoff have written extensively about the method over the years [20, 21], they avoid giving a detailed definition for the method, observing in one edited book that "if we were to attempt this, the reader would no doubt encounter at least one contribution to this collection which would violate our definition" [20]. Though consensus among experts is often an objective of its use, Turoff argues for the utility of the method even when consensus is not achieved, noting that the goal may be "to establish all the differing positions advocated and the principal pro and con arguments for those positions" [26].

Across the many variations in its application, four features characterize the Delphi Method: *statistical aggregation*, *anonymity*, *iteration*, and *controlled feedback* [23]. Statistical aggregation may be quite elaborate in studies involving

a large number of participants. But the number of participants (often called *panelists*) can be quite small (e.g., 20 or fewer). In these cases, statistical aggregation may be a simple mean or median of participant responses or a tally of those for and against a position. Similarly, though anonymity can be critical in certain rounds of the Delphi process it is sometimes waived in other rounds to, for example, improve participation and compliance [29]. In our application of the Delphi Method we use different forms of statistical aggregation and we apply anonymity thoughtfully.

More essential for the Delphi Method are the features of iteration and controlled feedback. The Delphi Method involves one or more iterations in which the facilitator initiates the current round of discussion with a summary of results from the previous round. Consensus or an understanding of the differing positions is then given an opportunity to emerge. We iteratively use a number of distinctly structured rounds to collect controlled feedback from PIM researchers, as described in the next section.

### METHOD

Our desire to build a picture of how PIM researchers understand present practices of personal information management arose at *PIM 2013* (<http://pimworkshop.org/2013/>) the sixth in a series of workshops concerning personal information management. In an afternoon breakout session, workshop attendees took turns sharing details of their own practices of PIM and discussing their observations from formal studies of PIM behavior. As discussion proceeded, an informal consensus emerged concerning the key challenges of PIM and notable alternatives for addressing each. As one person presented, other workshop participants would frequently offer, “I do that too!” or, “That’s a lot like something I’ve seen participants do in my studies.” To formalize this type of discussion and involve members of the larger PIM community, we decided to employ the Delphi Method.

Variations of the Delphi Method were used in five rounds grouped into two distinct phases, taking place from March through September 2014. In Rounds 1 and 2 of Phase 1, an effort was made to include PIM researchers with a wide variety of backgrounds in an open-ended dialog to collect notable instances of PIM behavior. Rounds 3, 4 and 5 of Phase 2 involved a smaller, select panel of participants who made a commitment at the outset to invest time to complete all three rounds.

#### Phase 1: Outreach

People employ a large number of practices in their everyday personal information management. The goal of Phase 1 of the study was to identify a manageable number of key PIM practices for closer consideration.

**Participants** for Phase 1 were recruited through broad announcement (e.g., email announcements to a PIM research mailing list) and active, direct solicitation of key PIM researchers by the authors. Twenty-seven researchers partici-

Panelist	Affiliation
Nicholas Belkin	Rutgers University
Harry Bruce	University of Washington
Robert Capra	University of North Carolina
Mary Czerwinski	Microsoft Research
Anne R. Diekema	Utah State University
Jesse David Dinneen	McGill University
Michael Eisenberg	University of Washington
Thomas Erickson	IBM T. J. Watson
Ina Fourie	University of Pretoria
Daniel Gonçalves	University of Lisbon
Jacek Gwizdka	University of Texas
Bradley Hemminger	University of North Carolina
William Jones	University of Washington
David R. Karger	MIT
Diane Kelly	University of North Carolina
Barbara H. Kwaśnik	Syracuse University
Gary Marchionini	University of North Carolina
Gloria Mark	University of California
Manuel A. Pérez-Quñones	Virginia Tech
Jaime Teevan	Microsoft Research
Amy Volda	Indiana University
Steve Whittaker	University of California

**Table 1. Phase 2 PIM panel participants.**

pated in Phase 1. A full list of participants can be found online at: [http://pimworkshop.org/delphi\\_report.pdf](http://pimworkshop.org/delphi_report.pdf).

In **Round 1**, participants were asked to, “Please share a specific instance of a notable PIM behavior,” and then, optionally, to provide details about the behavior including its intended benefits and rationale. They also provided circumstances through which they knew about the behavior, including, “I do this myself,” “Observed in a formal study,” or, “I’ve seen it informally in others.” A Google form was used to collect the submissions anonymously into a spreadsheet. After submitting an instance, participants were given a link to the spreadsheet so they could see other submissions and encouraged to submit additional responses. Round 1 resulted in 102 PIM instances.

To serve as controlled feedback for the Round 2, the facilitators reviewed all the submitted instances and grouped them into four categories: 1) Organization, 2) Finding and re-finding, 3) Task management, and 4) Fragmentation.

**Round 2** was structured as an asynchronous discussion about the four areas identified in Round 1. An editable Google Drive document was used to capture this conversation. For each of the four content areas, the facilitators seeded the document with a short prompt that described the main behaviors and choices that users face in that area, along with several open questions designed to stimulate discussion. For example, the prompt for the “Finding and re-finding” section read:

People appear to be using search ever more as a way to get back to their information – especially email messages. Still, recent studies indicate that navigation persists as a primary method for the return to files. How can search and navigation combine? When should people consider abandoning older ways of organizing (think use of email folders)? When should people opt for big “everything bucket” folders with minimal organization? When do/should people stick to organizations but use these in new ways (think search focused on file and folder names)?”

Participants were encouraged to read the prompts for each of the four areas and contribute their thoughts about the relevant behaviors and choices that users face, pros and cons of specific approaches, and successful alternatives. To support discussion, participants were given the option to identify themselves in their responses; all chose to do so.

### Phase 2: Focused Deliberation

The results of Phase 1 were analyzed by the facilitators and resulted in 36 unique everyday practices of PIM (Table 2). These practices provided the nexus for focused deliberation by a select panel of PIM experts in Phase 2, which consisted of Rounds 3, 4, and 5.

**Participants** for Phase 2 were recruited in a highly coordinated and focused fashion. Facilitators nominated participants for Phase 2 based upon their existing PIM research. Altogether, Phase 2 had 22 panelists (Table 1), including the seven facilitators. 14 of these panelists had also participated in Phase 1. Other researchers were invited to participate as Phase 2 panelists but were unable to do so (including five of the researchers who participated in Phase 1).

In **Round 3** of Phase 2 participants were asked to anonymously complete a form to recommend or advise against one or more of the 36 PIM practices resulting from Round 2. Participants were also invited to enter comments for each item to explain their reasoning. At the end of Round 3, for each of the practices the facilitators wrote brief summaries that included: a short description of the practice, a list of pros and cons, a statement on whether there was consensus, and a list of outstanding questions for the practice.

In **Round 4**, these summaries were put into another editable Google Drive document with space left underneath each practice for participant discussion and contributions. Panelists were asked to review these summaries and then contribute to the discussion for at least two practices.

Finally, in **Round 5**, the facilitators used the discussions from the previous two rounds of Phase 2 to create consensus statements for each of the practices. A final report document was created with an introduction and the 36 consensus statements. Participants were asked to read and edit this draft report and make sure the statements were complete, substantive, and concise. During this round several statements were merged or split. After editing the draft report, panelists were asked if they were willing to endorse the

report (all choose to do so), to highlight the practices they believed were particularly valuable, and to list up to five changes in PIM systems that they thought would be both impactful and reasonable to achieve in the near future.

### Facilitators

Facilitators are essential to the Delphi Method, as they structure each round and provide the controlled feedback for iteration from one round to the next. The authors fulfilled the facilitator role throughout the study. As is sometimes done in Delphi studies [20], the facilitators, themselves each involved in PIM-related research, also participated in each round of the study. Their participation was anonymous or not, according the structure of a given round.

In any Delphi study, the facilitator must take care to insure that the controlled feedback is a balanced reflection of participant viewpoints. This is potentially a greater concern when facilitators are also participants. On the other hand, the seven facilitators represented a diverse set of viewpoints, drawn from very different organizations and backgrounds. We believe this diversity promoted balance in the controlled feedback provided in the transition from one round to the next. We concluded that it was better to support richer discussion by including the facilitators than to exclude the viewpoints of a number of PIM researchers.

### RESULTS

The five-round application of the Delphi Method described above resulted in a list of PIM practices, each with a consensus statement, a list of pros and cons, and recorded vote of recommendation in favor or against. A list of the 36 practices is summarized in Table 2 and reported in detail at [http://pimworkshop.org/delphi\\_report.pdf](http://pimworkshop.org/delphi_report.pdf). In this paper, we present the details of the practices that were considered most valuable by the panelists, as expressed in the sign-off form of Round 5. These practices also garnered the highest proportion of “for” vs. “against” votes from Round 3.

Practices are presented in this paper to echo groupings created for Phase 2: 1) Information capture and retention for later use, 2) Finding and organizing information across applications, 3) Reminding and managing attention, tasks, and to-dos, and 4) Managing versions, controlling clutter, and combatting fragmentation.

The smaller set of practices that were “not recommended” by panelists are also listed, followed by a list of the desired near-future improvements panelists listed on the Round 5 sign-off form.

### Category 1: Capture and Retention

This category deals with ways people capture and retain personal information for later use. Three practices in this category received 10 or more “most valuable practice” (or *MVP*) nominations each in Round 5 from the 22 panelists.

**Take a picture with a smartphone:** Smartphone photos are a very useful way to capture non-textual information, whiteboard meeting notes, or paper notes prior to disposal.

CATEGORY/PRACTICE	Round 5 MVP	Round 3 FOR	AGAINST
<b><u>Information Capture and Retention for Later Use</u></b>			
Take a picture with smartphone (e.g., of paper notes or whiteboard)	13	10	1
Email yourself notes, thoughts, tasks/to-dos	12	14	0
Keep a notes or "thoughts" file (e.g., as .txt or Word doc) for each project or topic	10	9	2
Use calendar events to represent the past and to support reflection of what has actually happened	9	6	1
Email information to others not only to share it with them, but also to serve a keeping purpose	6	7	2
Use a special-purpose note-taking tool (e.g., MS OneNote or Evernote)	5	5	2
Bookmark webpages that contain interesting/personally important information into folders	4	5	4
Use a sound recording device/app to record to-dos or notes on the go	1	3	8
<b><u>Finding and Organizing Information Across Applications</u></b>			
Organize information by project (one folder per project)	15	12	0
Use standardized file and/or folder names [also do this across devices]	12	8	2
Rely on search to find information	7	7	4
Store research papers in bibliographic management software	4	7	1
Structure subfolders according to standard sections of a document (e.g. academic folders match CV)	4	4	1
Organize information using a small number of large folders	3	7	4
Use tags to label files & folders in several different ways	3	5	1
Re-find by searching within the top level folder of a branch where a document is likely to be	3	5	2
Place keywords into file & folder names to aid later search-based retrieval	3	3	3
Let a "smart system" figure things out for me (e.g., "iPad hides structure which works fine for me")	1	1	9
<b><u>Reminding, Managing Attention, Tasks/To-dos</u></b>			
Use calendar events to represent the future and to remind of tasks and aid in completion	13	6	1
Use email inbox as to-do list (including flags as reminders, or maintaining a single "to-do" email)	9	10	1
Maintain a single, 'master' list of all tasks/to-dos	9	7	1
Keep windows and tabs open as a reminder to do something	9	6	2
Use leading characters in file and folder names to change display ordering (e.g., "aaa-", "zzz-").	7	9	2
Keep a simple to-do list in a generic application such as word processor or spreadsheet	7	6	2
Keep a simple paper-based to-do list (e.g., in a notebook or in note cards).	5	8	3
Duplicate critical task information across apps and devices (e.g., to-do as both email and calendar item)	5	4	3
Multi-task (e.g., do simple tasks while watching TV)	4	7	3
Use a special-purpose task management system (e.g., Wunderlist, Things)	3	3	2
Use a desktop feature (e.g., Finder's 'sidebar') to organize currently active work items	3	2	1
<b><u>Managing Versions, Controlling Clutter &amp; Combating Fragmentation (esp. across devices)</u></b>			
Store files in the cloud (e.g., Dropbox, OneDrive, Google Drive)	17	13	0
Add characters or words to file names to add context (e.g., "v1" or "final" at the end of a file name)	10	14	1
Archive old/inactive information into designated subfolder (e.g. "archive")	8	10	0
Store persona information (e.g., username and log-in details) in a single file	5	5	5
Use email as a file system (i.e., to store and access files across devices)	3	2	1
Avoid multiple devices; use a single device (e.g., laptop) no matter what	1	4	8
Use a dedicated version control system (e.g., Subversion, Git)	1	1	4

**Table 2. PIM practices identified by panelists in the Delphi Method. Counts are always less than the number of panelists (22) because abstentions were allowed.**

In some cases the image can be discarded after near-term use. However, some images may retain value for a much longer period of time, in which case it is necessary to ensure the image can be retrieved at a later date. The image can be stored within an existing organizational scheme, or embedded in a document, email, or webpage where the surrounding text supports search.

*Pros:* Quick capture of information. Facilitates distribution to a group.

*Cons:* Hard to search or re-find. For longer-term use, may require organization and/or annotation to support search.

**Email yourself notes, thoughts, tasks/to-dos:** People frequently email themselves personal notes, thoughts, and tasks. The practice is recommended and is effective because email is often available when information needs to be captured and the content is likely to be viewed again as long as it stays at the top of the user's inbox. But the value of these notes is only as good as the user's overall ability to manage email. Emailing notes to oneself could exacerbate feelings

of being overwhelmed by email and add to email management overhead.

*Pros:* Can be done from any location/device with access to the Internet. Emails serve as reminders.

*Cons:* Contributes to overload of email inbox. Notes can get lost in one's flood of email.

**Keep a notes or “thoughts” file for each project or topic:** Keeping a notes or “thoughts” file is valuable because it is easy to forget items. Note taking produces a manageable record of precarious information items, thus preventing them from getting lost, and is also valuable to help synthesize and distill important ideas. The panelists widely endorsed the practice of keeping all the notes (e.g., thoughts, to-dos, and meeting notes) for a project together. However, there are many ways to accomplish this and the organization needs to be one that makes sense to each individual. When working on multiple projects with clear boundaries, keeping separate notes files for each project can be valuable. Such notes can be created as simple document files stored in project folders, or as emails with the project name in the subject line (sent to oneself and to project collaborators). Special purpose note-taking tools such as Evernote, TiddlyWiki, and Microsoft OneNote are recommended only for people with significant note-taking needs.

*Pros:* Reduces re-finding effort for people with projects that have clear boundaries.

*Cons:* Fragmentation of notes over multiple projects.

## Category 2: Finding and Organizing

The next category of PIM practices deals with the organization of personal information, and how people use their organizations to find information in their own personal space. One MVP from this category is discussed below.

**Organize information by project:** Panelists indicated overwhelming support for the practice of organizing information by project (one folder per project). Maintaining a “Projects” folder with individual projects as subfolders is a structure that is easy to remember and supports re-finding by confining searches to a subset of folders. However, many panelists noted that the practice is not without limitations. Such an organizational structure is problematic when project boundaries change and when cross-cutting takes place among high-level folders. For example, two panelists mentioned their “Papers” folder is also a top-level folder like “Projects”. More complex, matrix-like organizational structures could better support these situations, but are not widely implemented in current file systems. There was no consensus on how to resolve these issues, but one option that has worked for some is to create links among different folders.

*Pros:* Conceptually easy to identify project/folder. Ease of handling project (move, delete, backup, share, etc.)

*Cons:* Contents of projects might belong in multiple projects. Projects might grow into/from other projects.

## Category 3: Task Management

Another set of PIM practices deals with how people organize their personal information to manage their attention, keep track of tasks and to-dos, and remind themselves of things. Some of the MVPs in this category include:

**Use calendar events to remind of tasks, aid in completion, and to represent the future:** For future intentions, a person's calendar can provide a simple kind of task management, not only for scheduled meetings and appointments, but also to set aside time for attending to tasks (e.g., “finish report”). People should consider setting aside blocks of time for personal tasks. They can often include in the calendar event description much of the information needed to complete the task (i.e., as text, links or attachments). However, it should be noted that these “meetings with self” (i.e., with the intention to complete a task) may be more easily missed or re-scheduled than meetings that involve others. To better insure task completion, therefore, this approach should be used as a supplement to other approaches for task management. Also, while effective for deadline-type scheduling, people who must manage a larger number of tasks or tasks with no fixed deadline might instead consider a more formal task management system.

*Pros:* Calendars are an effective, visible place to reserve time to work on tasks and to aid in reminding.

*Cons:* Not all tasks fit into the time/date model of calendars. Effort is required to re-schedule “missed appointments” to complete a task.

**Maintain a single, “master” list of all tasks/to-dos:** Many people could benefit from the ability to view all (or most) of their key tasks and to-do items into a single place as it allows them to see all of their commitments and prioritize across tasks. To minimize the overhead of maintaining the list, the master list should be accessible across devices and locations. Suggestions include: an online note taking tool (such as Evernote or OneNote), a file synced in the cloud, a draft email, or a paper notebook that is carried everywhere. People may also find it useful to limit the scope of their master list, including only key items rather than trying to create a complete, comprehensive list. Items on the master list might also serve as a reminder and a reference to other project-specific documents with more details.

*Pros:* Provides an overview of all tasks and allows user to get a big picture view of their task space.

*Cons:* List takes time to maintain and update. Sharing can be a problem; also, can be difficult to sync with calendar.

**Use leading characters in file and folder names to change display ordering:** This method can be used to bring important information to the top or to send old or inactive information to the bottom of a directory or folder display list (e.g., “aaa-”, “zzz-”). This is a good technique for influencing the sorting order of a small number of files or folders in a directory display.

*Pros:* Quick way to move important files to the top and archived files to the bottom of file list.

*Cons:* Changing this organization scheme in large file sets could be labor intensive.

#### Category 4: Versions, Clutter and Fragmentation

The final category of PIM practices that we identified deals with how people manage multiple versions of documents to control file clutter and combat fragmentation. Three MVPs are discussed.

**Store files in the cloud:** Cloud storage services are a great method for accessing files from multiple locations or devices, for backups, and for collaboration. There are potential difficulties, however, with collaboratively managing and navigating the shared space. Users must also be aware of security and privacy risks and keep in mind that there may be regulatory and institutional policies and restrictions that apply in their particular cases. Some panelists recommended against storing confidential files in the cloud. As with any system, users are advised to make separate and regular backups of data stored in cloud storage. Cloud storage services can also create challenges with fragmentation of files and of users' online identities.

*Pros:* Great for collaboration. Good for backup and accessing files from multiple locations/devices.

*Cons:* Issues with collaborative management; privacy and security concerns; still need local backups.

**Add characters or words to file names:** Use of file names (especially by adding suffixes such as “-v1”) is a simple way to keep track of versions. People working in collaboration should discuss guidelines for naming of files and folders (e.g. avoid spaces and special characters for better compatibility across platforms and applications) and conventions for representing versions of a shared document (i.e. for the “when” and “who” of a version). This discussion rarely happens, yet people are usually able to figure out the meaning of trailing characters even when different conventions are used (e.g., “v1”, “v2”, ... vs. author initials). Establishing a convention for which version is truly “current” can be very important. More formal version control systems (e.g., Subversion or Git) provide better support but require training and ongoing effort that few are willing to invest. Consequently, formal systems are not currently recommended. However, in the near future version control may increasingly be supported in more accessible ways via widely used storage applications such as Dropbox, Google Drive and One Drive.

*Pros:* a simple effective way to track versions, and in a group, who was the last person to work on a document

*Cons:* conventions are often jumbled and collaborators rarely discuss conventions ahead of time. File names may “lie” as in “-Final” and “-ReallyFinal”.

**Archive old/inactive information into designated subfolder:** Archival of old/inactive information into a subfold-

er of a project folder (e.g., named “archive”) is a practical way to reduce clutter and is a recommended practice for people who have an abundance of digital storage. For those who archive to reduce the use of active storage space, alternate plans should be considered – e.g., designate a parallel archival storage (cheaper, less accessible) for old information, but use an organizational scheme that parallels the active information. Alternatively, archive not only within projects, but also archive whole projects when they are completed.

*Pros:* simple way to get old information out of the way but still nearby and “available” just in case.

*Cons:* information archived is harder to find. Archival takes additional time and trouble.

#### Practices That Are Not Recommended

Among the practices discussed by our panel, several elicited strong negative reactions. We present them here as “not recommended” practices.

**Not recommended: Avoid multiple devices; use a single device no matter what:** Many people have needs to use multiple devices and it seems likely that the number of devices we manage will *increase* in the future. Utilizing cloud-based storage can help, and it will become increasingly important for device makers to provide a consistent user experience in accessing cloud-based information from different types of devices. Some users may find partial specialization of devices helpful (e.g. only do work on a work-issued laptop).

**Not recommended: Use a dedicated version control system:** Complex, dedicated version control systems like Git and Subversion are not ready for widespread use in PIM. However, simpler forms of version control are supported in services such as Dropbox and Google docs, which automatically save versions of files (up to a point) and allow users to access older versions if needed.

**Not recommended: Let a “smart system” figure things out for me:** Systems that eliminate, hide, or automatically classify data into folders may work in special circumstances (e.g. for music) or when information is “low stakes” (i.e. the costs of mistakes in organization are not so bad). But a kind of information such as photos or music may be “low stakes” to one person and very “high-stakes” another.

**Not recommended: Use a sound recording device/app to record to-dos or notes on the go:** Audio recording is fast, but most current systems do not have good support for indexing, searching, and retrieving information stored in audio form. Often this means that the ease of recording notes by voice is outweighed by the costs of retrieving the information at a later point. However, voice recording may be helpful to note the current state of work just before an interruption, as part of workflows that include a larger discipline to listen to the notes again, or within the context of existing services that convert speech to text.

### Near-Future Recommendations

The final part of Phase 2 asked each panelist to list recommendations for changes to PIM systems that would be impactful and reasonable to achieve in the next five years. We collected 44 responses and grouped 37 of them to correspond to the categories of practice we have used elsewhere in this paper. These are discussed in greater detail below. The remaining seven were classified as “other,” and include recommendations for “adding PIM to K-12 education”, “improving security and privacy for data in the cloud”, and “integrating voice input and analysis into more applications”.

#### *Capture and Retention*

Two near-future recommendations related to the capture and retention of personal information. Panelists would like to see PIM systems extended to support the flexible addition of extra information to any application or document. This in turn could support more focused search and filter options. Additionally, panelists would like increased support for reflection in task management and calendar applications. A person could learn about their own practices through analysis of their captured personal information.

#### *Finding and Organizing*

Most (19) of the near-future recommendations related to the finding and organizing of personal information, with several focused specifically on improving file systems. A number of the recommendations in this category build on the suggestion to capture and retain additional metadata about files and folders, and suggest ways this metadata might be used. For example, it could be used to support customizable orderings of files and folders, or robustly link local and cloud-based information. Additionally, metadata that is common across files in a folder could be used automatically identify new candidates for inclusion in the folder and, more generally, to aid in the organization of information. Other common recommendations related to improving search support in file systems by, for example, providing people more control over the searches they issue.

#### *Task Management*

Eight recommendations related to tasks, to-dos, and attention management. Common suggestions included easier capture of tasks, the ability to more effectively record and use notes via speech, and features to help in annotating folders. Panelists highlighted the need to integrate or cross-link to-dos with other information items. To accomplish tasks, panelists described needs to associate resources with to-do items. Desired associations included email and calendar, notes and projects, and the flexibility to integrate any other resources needed to carry out a task. One participant requested an easier way to break down larger tasks into smaller ones in order to get more work done (such as is done in *self-sourcing* [25]).

#### *Versions, Clutter, and Fragmentation*

Finally, eight recommendations focused on needs for improved synchronization of files across devices, version con-

trol, and cross-linking of information. The suggestions underscore problems users face managing information stored in different locations and devices. Panelists described needs not just for personal files, but also for sharing files with others. Panelists suggested developing versioning systems to help users maintain awareness of current file versions, and noted that a key aspect is the need for more usable version control systems. In cases where turn-taking is still the preferred means of collaborative authoring, for example, systems might more directly support the creation of snapshot versions (e.g., identified by the who, when and what was done) prior to transfer from one author to the next.

### DISCUSSION

We have presented PIM practices identified through the Delphi Method related to the capture and retention of personal information, how to find and organize personal information, task management, and controlling for versions, clutter and fragmentation. We now discuss these findings in terms of the three contributions outlined in the Introduction: 1) the practical value of the recommendations, 2) the identification of specific areas for future research and development, and 3) use of the Delphi Method in for HCI research.

#### **Practical Prescriptions for PIM**

The list of 36 PIM practices we identified represents an important collection of practical advice for information workers. While some of these practices may be familiar to people within the HCI community, we nonetheless expect that most readers will come away with ideas for at least a few new practices to try, and we anticipate an even greater practical impact among the general public.

In addition to recommended practices, our findings also suggests practices to avoid. These practices shared traits of impracticality and inefficiency, and many evoked a fear of a potential loss of control. For example, using only a single device, while attractive to minimalists, is not feasible because no individual device can sufficiently reproduce every other device’s functionality. It is better for people instead to face the challenges of a multi-device world directly, and some of the recommended practices suggest ways to do this (e.g., through increased reliance on cloud storage). Similarly, while it may seem attractive to use “smart” systems, we found that such systems are likely to meet a person’s needs only in circumscribed domains where the items to be managed all share a small set of meaningful attributes (e.g., “artist”, “album”, “song”, etc. for music) and a person’s interactions with the items are predictable.

#### **Future Directions for PIM Research and Development**

In addition to having immediate practical use, our findings point to areas where PIM research and development efforts could have high impact. For example, many of the recommended practices illustrate ways people creatively appropriated their PIM tools, sometimes making work-around use of these, to meet their needs. Consider the recommended practices of using leading characters in filenames to effect order and of using subfolders to clear away clutter. While



these are both good practices, their aims might be better met through file system improvements that allow a user to specify whether and how items should be shown in a display. Likewise, the recommendation to “Organize information by project (one folder per project)” might be better managed via explicit tool support. Relevant information (e.g., notes, component tasks, target completion date, and the desired state when done) could be associated with a project folder using metadata, making this information also available in other contexts.

In addition to better supporting existing behavior, areas where limited consensus exist suggest avenues for future exploration. Some of the “not recommended” practices, for example, may represent solutions that have not yet been perfected. For example, while panelists did not recommend existing text-oriented version control systems, they did see a near-future of version control where such systems will become easier to use and more directly meet the needs of their non-coding user (see, for example, early implementations in Dropbox, Google Drive, and Microsoft’s One Drive). Likewise, as tool support improves and is better integrated into existing workflows, the use of sound or video may very well shift. Recordings may never take the place of active engagement in the lecture or meeting, but seem likely to eventually provide real value in support of task resumption or reminding where memories are partial and notes ambiguous.

### The Delphi Method for HCI Research

We have shown that the Delphi Method provides a reasonably rapid, cost-effective means to achieve consensus among researchers with expertise in PIM concerning the current state of PIM practices. While the Delphi Method was recently used to better predict the future of HCI [22], we believe that the method also has significant utility when directed to the practical present of HCI. There are many areas in HCI where the Delphi Method could engage experts in a useful dialog “for telling” key choices, alternatives, and pros/cons for identified practices. Potential application areas of the method range from identifying the best-practices in web design, to facilitating a nuanced discussion of multi-tasking and how to interleave tasks.

The Delphi Method is complementary to more traditional methods of data collection, including interviews, surveys, observations, and focus groups. The Delphi Method, as used in this paper, is second order: rather than focusing on individuals practicing PIM, the focus was on researchers who observe, interview and survey individuals practicing PIM. However, as discussed in this section, the method’s outcomes can suggest additional first order studies. In future work, we would like to engage samplings of people from the population targeted by the recommendations (i.e., information workers) in studies to selectively and directly assess the efficacy of the recommendations.

### Limitations

Though variations of the Delphi process were used to establish consensus among PIM researchers concerning practices of PIM to recommend (with qualification) and to advise against, this consensus does not per se establish validity. In addition, although our panelists discussed many diverse research and personal experiences, there may be areas of PIM practice that were missed. Many practices recommended by the researchers (and observed in the participants of their studies) depend on existing tools and infrastructure, such as the near universal support of file and folder semantics. Other practices depend upon another universality of our digital world: Email (and related support for a digital calendar). Tool improvements that work to extend rather than replace these are likely to find the best reception (see, for example, [3, 7, 15]). But our focus on current practices limits our ability to observe entirely new ones.

As PIM research continues to shed light on how people do PIM and how they might do it better, the recommendations reached in this paper may ultimately prove wrong. Some may become dated as the tools and devices that support PIM improve. However, the recommendations represent the current consensus of experts in the field. We believe the Delphi Method will continue to be useful as an effective means to update our understanding of current PIM practices. In future work we plan to use the Delphi Method to understand people’s PIM practices more deeply, including how the practices evolve over time and which combine well towards overall, coherent, sustainable strategies of PIM.

### CONCLUSION

Given the existing variation in people’s personal information management practices, it is unlikely that we will ever be able to determine the *best* practices of PIM of universal application. But an ongoing discussion of challenges, alternatives and the pros and cons of each may at least help individuals identify *better* PIM practices than they currently use, and allow them to consider the costs and benefits that apply in their adoption. As described in this paper, such a discussion can be structured and facilitated through applications of the Delphi Method.

We used the Delphi Method with a panel of PIM experts to elicit and assess 36 practices of PIM. The top-ranked “MVPs” in this set are worthy of consideration for immediate adoption. These practices relate to the capture and retention of personal information, how to find and organize personal information, task management, and the control of versions, clutter and fragmentation. Our findings also point to areas where PIM research and development efforts could have high impact.

This paper presents a detailed example how the Delphi Method can be used in HCI research as a complement to more established methods of inquiry. Rather than studying people’s PIM behavior directly, we show that much can be learned through careful engagement of the researchers who themselves study people in their daily practices of PIM. The

Delphi Method should find useful application in other areas of HCI as well where it may serve to complement and catalyze existing research methods.

#### ACKNOWLEDGEMENTS

We appreciate the PIM researchers who made time in their busy schedules to participate in the Delphi process. We also thank Richard Neiman, M.D., for his identification of Delphi Method use among medical practitioners.

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