

Finders/Keepers: A Longitudinal Study of People Managing Information Scraps in a Micro-note Tool

Max Van Kleek, Wolfe Styke,
David Karger
MIT CSAIL
Cambridge, MA, USA
{emax, wstyke, karger}@csail.mit.edu

mc schraefel
School of Electronics and Computer Science
University of Southampton
Southampton, United Kingdom
mc+chi@ecs.soton.ac.uk

ABSTRACT

Mainstream PIM tools capture only a portion of the information that people need to manage. Many *information scraps* seem to exist that don't make their way into these tools, instead being relegated to sticky notes, text files, and other makeshift storage, or simply being lost. In an effort to understand the role of these information scraps, the underlying needs they reflect, and the way PIM tools must be modified to support those needs, we created List-it, a *micronote* tool for quick and simple capture of information scraps.

In this article, we analyze the notes and interaction logs of 420 volunteer users of List-it over a two-year period of study (August 2008-August 2010). We contextualize our analysis with results of two surveys and an e-mail interview we conducted in October 2009. We find that people are drawn to List-it by the ease and speed of note capture and by the ability to record scraps with arbitrary content that blends or completely escapes the types and roles imposed by our rigid PIM tools. Notes are taken to serve a variety of needs – reminding, reference, journaling/activity logging, brainstorming, and to indefinitely archive information of sentimental or personal value. Finally, while people differ considerably in the ways they keep information, our findings suggest such differences can be described as a combination of four distinct strategies, enriching the Filer/Piler distinction identified for classic document management.

Author Keywords

Personal information management, Note-taking

ACM Classification Keywords

H.5.2 Information Interfaces and Presentation: Miscellaneous

General Terms

Experimentation, Human Factors

Permission to make digital or hard copies of all or part of this work for personal or classroom use is granted without fee provided that copies are not made or distributed for profit or commercial advantage and that copies bear this notice and the full citation on the first page. To copy otherwise, to publish, to post on servers or to redistribute to lists, requires prior specific permission and/or a fee.

CHI 2011, May 7–12, 2011, Vancouver, BC, Canada.

Copyright 2011 ACM 978-1-4503-0267-8/11/05...\$10.00.

INTRODUCTION

Information scraps, the bits of information that end up misfiled, lost, or forgotten in the course of our daily activities [3], point to the potential for improving the effectiveness of personal information management tools designed to help us stay organized. While different people vary in their degree of organization, nearly everyone has experienced the frustration of missing an appointment, or losing information they wrote somewhere instead of filing it in its dedicated place.

Our previous study examined the nature and sources of information scraps - specifically, the reasons that, despite the existence of digital calendaring apps, task and contact management tools, to-do managers, bookmark and password keepers, and so on, information often failed to make it into these tools [3]. This study also examined the ways individuals sometimes fashioned their own “home-grown” solutions for keeping track of information, such as keeping sticky notes in one’s wallet, placing notes into word processor documents, and sending self-addressed emails. The three most common reasons people resorted to these imperfect solutions were as follows: first, the time, effort or attention required to put information into dedicated PIM tools exceeded that which was available at the time it was written down; secondly, there existed a preponderance of information that didn’t seem to fit in any one PIM tool – from proverbs to poetry, memorable guitar chords and “fantasy football line-ups”, to passwords and IP addresses, for example; and, finally, there appeared to be a lack of visibility of information once it had been captured in PIM tools (“once it’s filed it’s gone, and I forget about it”) [3].

Micro-note taking tools [10], however, comprise a new class of PIM tools that are growing in popularity and seem to support users in all three of these areas: they are easy to use, optimized to let people capture arbitrarily small bits of information quickly and easily, and they keep these information items readily available in visible locations. These tools thus are a close digital analog to sticky notes, offering flexible, fast storage while lacking the overly-complex, advanced organizational facilities available in structured PIM tools.

What role do digital micro-note tools play in the personal information practices of those who are adopting them? Are they being used in some ways to supplant structured tools for certain purposes, or to augment them? Are these micro-

note tools fulfilling the needs of information scraps which were previously relegated to paper? For example, are these tools being used as temporary storage buffers for items before they get filed into structured tools, much as Post-It notes are used? Or is it the final resting place for information items? What kinds of information get stored, and how is information expressed when captured, and 'filed', if at all? Once captured, when and under what conditions is such information retrieved? What are the unmet needs surrounding these tools? Are the advanced features and organizational capabilities offered by structured PIM tools necessary?

From the perspective of PIM research, micro-note tools present an unprecedented opportunity to study the information needs of individuals in great detail. By imposing few constraints on the kinds or forms of information that can be captured, notes are captured more accurately and better reflect people's information needs "in raw form" than items that have been forced to take a particular structure, such as in traditional PIM tools. Also, the ease and speed with which micro-note tools can be used enables the user to employ them the moment a need arises (instead of at some later point). In correlation, the moments and ways at which micro-notes are taken or accessed reflect when and how information needs naturally arise.

Thus, we sought to use a micro-note tool itself as an instrument to allow us to examine personal information needs, in particular, to address the questions surrounding unmet needs in structured PIM tools. In this paper, we present an analysis of a two-year deployment of our instrumented micro-note taking tool called List-it, a Firefox add-on which has had 16,138 registered users since its release in August 2008. Our analysis is based on 66,151 notes and accompanying 21,353,324 activity logs for 420 users who met the minimum usage criteria from 1,514 that volunteered to participate in the study. To better understand the place that List-it occupied among other tools, we also conducted interviews with 18 users to determine how it fit into their greater personal information practices, as well as to obtain the users' reflections on how these tools could better serve their needs.

To our knowledge, the study presented in this paper is the largest, and longest, digital note-taking study that has yet been published. To enable the greater research community to benefit from this rich data set, an additional contribution is herein made, in the form of the release of the MIT Information Scraps Corpus (MISC)¹, a public, growing repository of redacted micro-notes that the participants of our study have voluntarily contributed for PIM science. We hope that this burgeoning data set will further advance research in this area, much as other large NLP corpora have.

RELATED WORK

Our interest in micro-notes derived from a basic inquiry into why people often kept information on scraps of paper, instead of filed and categorized in the many dedicated digital PIM tools available today. The overwhelming abundance

of these "information scraps" represented failures of digital PIM tools, which, in turn, potentially held clues to ways that they could be improved. Our studies of these artifacts [3] revealed properties of digital PIM tools that caused people to avoid using them in favor of free-text notes and paper. The most significant of these were time and effort, cost of use, insufficient availability, and a lack of flexibility or visibility of information filed in these tools. This study also documented *appropriation strategies* people used to co-opt and adapt tools to better meet their needs.

Regarding other investigations of micro-notes, Campbell et al.'s [4] examination of "notable information" found that participants predominantly preferred to use paper instead of digital PIM tools, because digital tools were perceived to be too cumbersome and slow. Lin, et al., found that notes to self were primarily used for temporary storage, and as prospective memory aids [10]. Our findings in this paper, however, suggest that notes-to-self also often serve as reference items, chronicles of activities or progress towards goals, and archives of items kept for emotional/personal reasons. Unlike the ephemeral uses revealed by Campbell, these roles suggest that information scraps often serve needs that require long-term keeping and maintenance,

Among studies of more general note-taking activities, Khan characterized the social, environmental, psychological and tool-based factors that influenced note-takers in various settings [7]. These findings substantiated earlier hypotheses by Lansdale [8] framing the psychological factors that influenced a person's choice of tool and strategy. His position was based on an earlier study by Malone, which recorded differences among individuals in the ways people organized the paper documents in their offices [13]. Such differences, he contended, arose from latent differences among people's needs, workflows and personal styles. For some, *piling* was an effective coping mechanism, because it allowed recently-accessed information to be rapidly accessed; while for others, keeping things filed was simplest and most efficient.

Harper and Sellen's studies of work places revealed that, because of paper's versatility, the use of paper actually grew as workplaces became increasingly digital [14]. Such findings have led to research seeking to marry the affordances of paper to the capabilities of digital PIM. These include prototypes using graphics tablets [12], digital pens and paper (e.g., [5], [9]) along with other devices (e.g., [18]).

Yet the widespread acceptance and ultimate adoption of digital paper remains unclear. At present, most PIM activities still take place on desktop and portable computers using a variety of structured PIM tools. Recent studies finding convenience and ease of use to be primary factors that influence the degree to which particular tools are used [6] would suggest that tools designed to optimize the quick and easy capture of information, such as *snippet-keepers*² and micro-note tools, would be more effective than those that have not been designed with these priorities in mind. In fact, our initial examination of *List-it* usage [15] found that simple

¹this corpus is available at <http://listit.csail.mit.edu/MISC>

²<http://db.tidbits.com/article/6529>

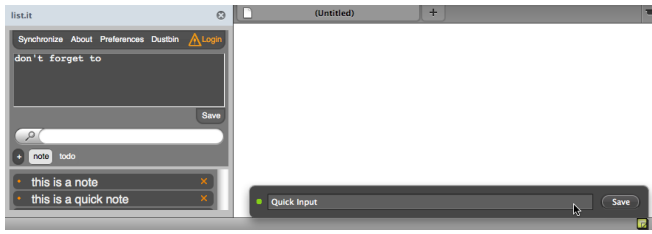


Figure 1. Main List-it interface, situated in Firefox’s sidebar, with quick note capture box in lower-right. New notes are created by typing in the top box in the sidebar; a keyword search field and the notes collection are visible underneath.

micro-note tools allowed people to create notes quickly and plentifully. But how do such tools actually change the personal information landscape – do they make people more organized? These, in essence, are the questions this study attempts to answer.

METHODOLOGY

Our study focused on the following research question (RQ):

- *RQ: To what extent are micro-note tools solving the information scraps problem and why? What is suggested by the ways micro-note tools are used towards unmet needs of other PIM tools?*

We addressed the RQ, in turn, through the following specific questions:

1. *MNQ1: What do people put into notes to themselves?*
2. *MNQ2: What purpose do these notes serve ?*
3. *MNQ3: Are there differences in personal strategies in the ways people keep and file notes?*

In our consideration of these questions, we created List-it, a simple note taking tool, which served as our primary data collection instrument. List-it, described in detail in [16], is made to resemble and offer very similar functionality to other available quick micro-note tools such as NoteLens, Simplenote, and Evernote, featuring simple creation and editing of any type of free text note, quick keyword search, and basic note reordering. List-it is simpler than some of these in that the display of notes is constrained to a single-level list in the web browser sidebar and that notes can be reordered by simply dragging and dropping them within the list. Searches can be saved for rapid re-searching using the “quick search bar”, which is a set of saved searches represented as radio buttons for quick invocation. The entire List-it UI can be hidden or revealed with a hot key or via the note icon; likewise, a quick input box allows users to create new notes without having to open the interface.

Data collection

Study participants were recruited through an interface displayed when List-it was first installed on a person’s computer. Participation in the study was purely voluntary and

not required to use the tool, which was made widely available on the web as a free and open-source³ note-taking add-on for Firefox in August 2008. The only criteria required to participate was that participants be at least 18 years of age, and agree to the study terms surrounding data access and handling. No further screening was done.

While random, this process of recruitment was likely to have been biased by at least three factors: first, study participants had to be Firefox users to use the tool, which accounted for 29% total browser share⁴ at the time of the study. A second factor consisted of the channels where List-it gained its initial exposure; although we did not explicitly promote List-it, its availability was picked up by a few prominent news outlets internationally, including *Forbes*, *The New York Times*, and *Le Monde*, in addition to receiving “hot software pick” status by PC Magazine. This coverage caused a massive surge of new users and signups; most of the approximately 10,000 users of its first year of deployment were readers of these publications, a fact which is reflected in the demographic statistics collected during the survey (summarized in Analysis 4). Finally, since there was very little pressure to participate, it is likely that our sample was biased towards people who were in general more inclined to participate in a purely unpaid, volunteer study. This could include those who were particularly interested in note-taking, had more time to read and consider such a study request, or had other motivations for volunteering.

For each of these participants, any interactions with List-it were logged and uploaded to our servers, along with notes taken. From the period of August 2008–August 2010, 1,514 users volunteered to join the study (comprising 9.3% of the 16,138 registered user base of the system). To focus analysis on users of List-it who had fully adopted the tool, we selected only volunteers who had accumulated at least two weeks of tool use. This yielded 420 users in the resulting study set, who collectively generated 66,151 notes and 21,353,324 activity log event records over this period.

In order to better understand the contents of logs and notes, we conducted a survey and email interview with a subset of users. The survey, conducted one year after List-it was released, asked active users to identify what other personal information tools they routinely used, and to comment on how List-it fitted in among these other tools. The email interview, conducted at roughly the same time, consisted of free response questions that invited users to describe their strategies for keeping information. These insights allowed us to compare their note taking practices with their actual practices.

ANALYSIS AND FINDINGS

This section presents the findings from three different sets of analyses: in the first, we examined the kinds of notes people took with List-it; the second analysis identified personal variations in how notes were created and kept; the third studied the dynamics of note creation and retrieval answer the

³<http://code.google.com/p/list-it>

⁴http://en.wikipedia.org/wiki/Usage_share_of_web_browsers

question: *how fast and frequent?* The methodology used for each analysis is given below, followed by the corresponding findings.

Analysis 1: What do people keep in List-it and why?

To gain insight on RQ, we started with a qualitative analysis, grounded in a previous study of *information scraps* [3], of the notes participants took using our tool. This initial analysis was conducted on two levels. The first was an analysis of the basic consistency of each note – coders were asked to characterize the kinds of information represented in the note, such as phone numbers, date/times, URLs, references to things, names of people, recipes, and so on. The second level was to try to identify the note’s role, by attempting to determine its purpose for creation.

Note consistency

To derive the categories for the analysis of note consistency, eight expert coders performed open coding on 540 randomly chosen notes created by study participants. These initial types were pooled, matched, and revealed as 62 categories which were clustered into 48 final categories which were labeled with descriptive names such as *to-do*, *web bookmark*, *contact information*, *web site passwords* and so on. For this analysis, each note was assigned to at most one category. Figure 2 displays the resulting frequencies of each note type.

This process yielded a distribution with an exponential shape (Figure 2), signifying a large variety of different types of notes in List-it, with a few very common forms. The head of the distribution was dominated by many forms typically associated with structured PIM tools: calendar events, address book contact information (names with phone numbers and email addresses), to-do items, and web bookmarks. These collectively comprised only 278 (51%) of the distribution. The remaining 44% was distributed among forms that were typically less associated by mainstream PIM tools, such as passwords, tracking/shipping and confirmation codes, travel itineraries, meeting agendas, word definitions, code snippets, recipes, etc. The final 21 categories comprising the tail of the distribution each occurred for a single note in the sample, and included types such as expressions, jokes, problem statements markup, singular codes and thoughts.

Note roles

A separate subsequent analysis was conducted to identify *note roles*, that is, the likely *purposes* that each note was intended to serve. The following five roles were derived from the initial coding exercise described above:

1. *Memory triggers* - Notes whose primary purpose is to bring something to mind (make information salient).
2. *Reference items* - A piece of information that is likely to be needed at a particular later point in time.
3. *External cognition* - Notes where the purpose of creation is to facilitate thinking aloud on screen (as if writing on paper).

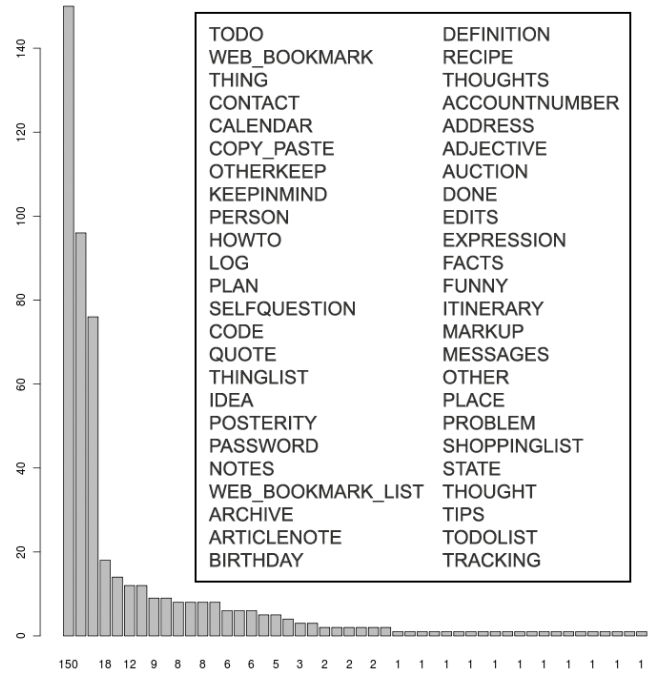


Figure 2. Count of note forms per category in random sample of 540 notes. Notes were assigned to at most 1 category each; 48 final categories were identified. (3-coders; Fleiss $\kappa = 0.71$). Most common classes included: *TODO*: a note explicitly marked with “to do”, or starting with a verb; *THING*: a single non-person entity (proper or common noun); *THINGLIST*: multiple named or common nouns (e.g. “car, turnips, cat”); *WEB BOOKMARK*: URL alone or w/ label; *OTHERKEEP*: codes, dates, and numbers that are non-word character sequences; For a complete list of form class descriptions see <http://listit.csail.mit.edu/study/chi2011/classes.html>

type N (%)	co-occurs	%	forms	%
mem trg: 303 (66%)	reference	29	todo	42
	ext cog	12	noun	15
	pers arch	8	web bkmk	7
	journal	8	contact	3
ref: 215 (47%)	mem trg	41	web bkmk	41
	ext cog	10	noun	7.5
	pers arch	12	contact	6.9
	journal	10	copypaste	3.7
ext cog: 59 (12%)	mem trg	65	todo	18
	ref	39	question	8
	pers arch	20	draft	4
	journal	19	idea	3
pers arch: 61 (13%)	mem trg	38	copypaste	32
	ref	43	idea	14
	ext cog	11	quote	9
	journal	13	joke	8
journal: 43 (9%)	mem trg	51	todo	37
	ref	51	mtg mins	1
	ext cog	26	noun	1
	pers arch	18	plan	1

Figure 3. Distribution of roles resulting from coding notes by inferred intent for capture. Each note (n=473) could be assigned multiple roles ($\mu = 1.44$ roles/note) so percentages do not add to 100%. 2nd column: co-occurrence probabilities of purposes. 3rd column: breakdown of the most common forms (from Fig 2) arising in each role.

4. *Logging, Journalling, Chronicling* - A note that serves as a record of something that the user did or experienced, to help keep track of this event.
5. *Emotional/personal archive* - An item kept for personal value, typically for emotional, aesthetic or sentimental reasons.

This last category was formed to encompass a set of emotional, sentimental and personal reasons for keeping information cited by users in the survey; reasons such as “jokes I like”, “verses from the Bible”, “quotes that I like”, “lyrics for my favorite songs”, and “code snippets I was proud of”. This category was distinguished from the reference items in that they were likely to be retrieved for emotional rather than functional needs - e.g., to brighten the user’s day rather than to log into a web site.

Role coding was performed on 600 notes by 4 coders; each coder was asked to assign a primary note role and as many secondary categories (on a scale from 1-5) as deemed necessary. Finally, coders were asked to propose any new roles while examining the sample. No such new categories were proposed. Measuring inter-coder reliability revealed a moderately strong agreement (Fleiss $\kappa = 0.615$) among primary categories, or $\kappa = 0.85$ when secondary categories (with a score of 4 or higher) were included. At this threshold, 473 (79%) of the notes were assigned to at least one category, with an average 1.44 role labels per note overall (the remaining 140 notes were predominantly test notes or in a language that the coders could not read). To simplify discussion, all subsequent note role analysis was done with these 473 notes, pooling secondary and primary categories together. From the level of agreement, we concluded that external observers not having access to the original note author could still use clues in most notes to moderately strongly agree upon their purpose(s) of creation.

From this coding process, we estimated the frequency of these intents and the affinity between roles, that is, the frequency with which a note with a particular role also served other roles (Figure 3). This figure also displays the connection between the previously identified forms and each of these roles, displaying the most common forms occurring in each. Memory triggers comprised a majority (66%) of the coded notes, and also overlapped the most with the other categories. “Pure” memory triggers, defined as notes that contain no other information besides a key word or phrase intended to bring something to mind, comprised a large portion (57%) of these memory triggers. Since these items did not contain additional information, they were distinguished from reference items easily. However, information that might be forgotten was often included in memory triggers, such as contact details (e.g., the phone number or e-mail address of a person that needed to be contacted, a web URL of a site that needed to be visited, room number and time of an event that was to be attended) – and thus these notes doubled as reference information. For many kinds of items, there was some ambiguity as to whether their purpose was to remind the user of the event, or to serve as a reference for these details. Coders labeled an item as a memory trigger when it

was explicitly labeled to-do, phrased as an imperative (e.g., ‘call dan 252-2322’) or had a clear date (e.g., for an event to be attended).

A large variety of items fell squarely in reference - these included logins and passwords for web sites, how-tos including recipes and instructions for operating office equipment, personal addresses, and difficult words to spell. Coders labeled 47% of notes as reference items.

Notes in the external cognition role occasionally overlapped with memory triggers when they resulted from the process of brainstorming possible actions to take next. The following is an example of such a note by a participant, taking the form of a plan containing various other forms, including to-do items (serving as memory triggers) and contact information (for future reference):

```
next steps XXXXXXXX
done- call ZZZ marketing
consider incentives? no others require it; our pricing is
more competitive
...
```

Are notes in roles characteristically different? Figure 4 conveys the result of a comparison of notes that fell into each role along several simple features: note length (in characters, words, and lines), average lifetime, and probability of deletion. The tests were blocked by participant to control for inter-participant variation, and significance was determined using pairwise Tukey-HSD post-hoc tests. All feature tests rejected the null hypothesis for role at $p \ll 0.001$ as follows: note characters $F(3,689)=27.02$; tokens $F(3,689)=23.23$; lines $F(3,689)=8.62$; lifespan in hours $F(3,499)=11.06$; probability of deletion $P(3,1052)=59.40$. All feature tests also rejected the null hypothesis for participant ID, indicating that differences among individuals contributed significantly to the means and standard deviations computed above.

Comparison with survey responses

In survey two, we asked people to self-report how much of each of 12 types of information (listed in Figure 5) they kept in List-it. Among these types, the most common kinds of information kept in the tool were: things to look up some day, ideas/brainstorming, short and long-term to-dos and “things pasted from the web they wanted to keep”. Bookmarks, contact information, and calendar events were kept less frequently, with only 36% of respondents reporting using List-it to store bookmarks *at least some of the time*.

This self-reported statistic seemed to contradict the form frequency analysis (Figure 2) - which found *Web bookmarks* to comprise the second most frequently found form after *to-dos*. Examining the free response section of our surveys, we found that kept URLs were often perceived as not actual bookmarks, but rather temporary holding places for things to look at later: “[I keep track of] urls that are interesting but not worth a bookmark”; “Links to web sites (only temporary links. for permanent links I use Delicious)”; “I use List-it most to store URLs people reference on IRC channels.

role	mean length chars/words/lines (SD)	mean lifetime in hours (SD)	mean p(delete) (SD)
all in study ($df = 66151$)	162.35 / 17.57 / 2.97 (825.74/88.82/9.72)	1155.86 hrs (40.149)	0.55 (0.48)
memory trigger ($df = 303$)	55.56** / 8.53** / 1.49** (88.78/14.79/1.69)	1005 (46.00)	0.70** (0.45)
reference ($df = 215$)	108.69 / 12.23* / 1.95 (240.67/41.26/2.23)	1678 (3042.26)	0.45* (0.49)
ext cognition ($df = 59$)	137.22 / 22.52* / 2.06 (196.30/32.93/2.60)	1157.28 (2056.74)	0.49 (0.5)
personal arch ($df = 61$)	166.32 / 26.16/ 1.83 (443.89/78.14/1.99)	1794.79* (950.82)	0.30** (0.5)
journal ($df = 43$)	188.60 / 18.34 / 2.27 (163.08/26.32/2.07)	1121 (2002.28)	0.411* (0.5)

Figure 4. Means and standard deviations of features by note role. ANOVA tests are separately computed for each feature, blocking by participant to control for individual variation. ANOVA tests reject the null hypothesis (that all means are equal) at ($p < 0.001$) for all features; significance indicators in the table ($p < 0.001$, * $p < 0.01$) further indicate where pairwise differences involving the particular role exceeded significance against the other roles.**

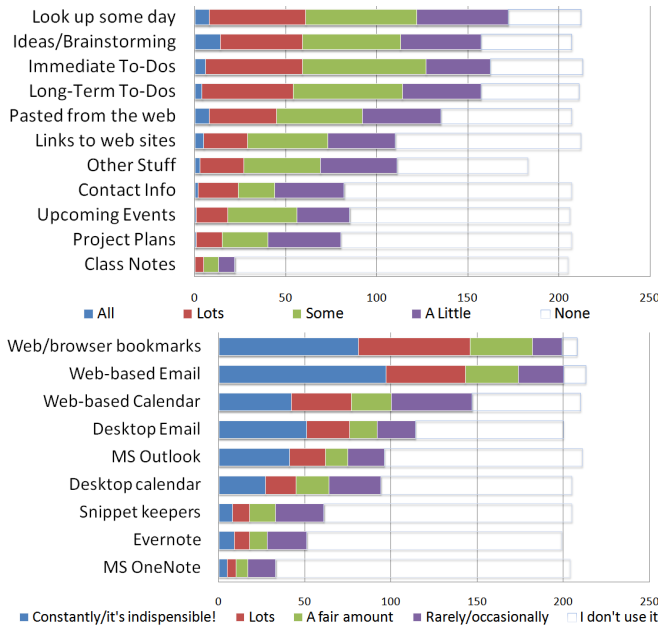


Figure 5. Survey responses (255 respondents) for questions: (top) What do you keep in List-it? (bottom) How much do you use the following specific types of tools? Totals vary for each row because some respondents did not respond to particular questions.

I'll throw them into List-it and review them later to see if I need to bookmark it [sic]"; and finally "It's a great halfway house for bits as I bounce between references and attempt to compose something".

Thus, many of the web bookmarks encountered in the coding process were not perceived as bookmarks by users, but merely as "temporary links" – a kind of memory trigger and reference item to remind the user to go back, look at the link, and later file away appropriately. This use of List-it, as a sort of task deferral tool/temporary buffer for when things come up in the middle of a primary task, seems to be a unique role that List-it fulfills.

Analysis 2: Do different people use List-it different ways?

PIM studies have repeatedly found that personal styles strongly influence the ways that individuals keep information using various tools. In terms of office paper organization, for example, Malone [13] concluded that individuals tended to either be a *filer*, a person who files things fastidiously, or a

piler, someone who does little organization and lets things land where they fall.

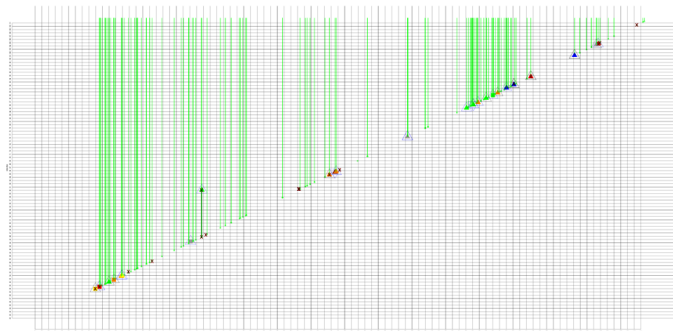
We hypothesized that individuals' use of List-it might also exhibit such similar interpersonal differences. Since Analysis 1 already revealed significant inter-personal differences in the lengths, lifetimes, and probability of deletion of notes, we focused this analysis of note collections as a whole; specifically the temporal dynamics of note creation, edits and deletion, and the growth of note collections over time. To reveal such patterns, we constructed note lifetime visualizations, examples of which are visible in Figure 6.

Examining participants' timelines revealed clear similarities and differences. To more concretely understand the core patterns exhibited, 3 coders clustered the participants' visualizations based on appearance. Four distinct strategies emerged from this process as follows:

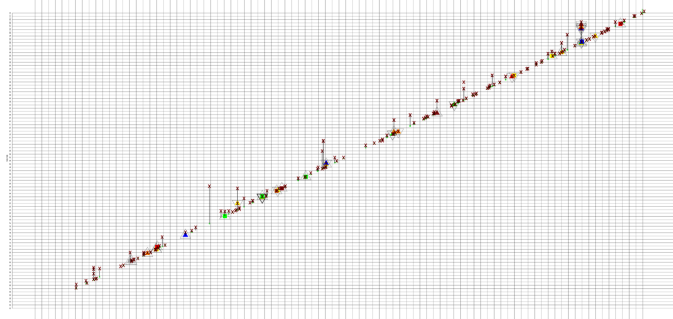
- *packrats* - Keeping many items indefinitely without modifying them.
- *minimalists* - Deleting notes soon after creation to keep List-it tidy/minimal.
- *periodic sweepers* - Periodic cleaning up (deletion) of large numbers of notes in batch sweeps.
- *revisors* - Individuals who repeatedly edit the same notes over and over.

Examples of timelines exemplifying each strategy are visible in Figure 6a-d. Coders labeled each participant's timeline with four ratings ("None", "Some", or "Much") according to the degree with which it exhibited the characteristics of each of the above categories. As done in Analysis 1, pooling coders' votes at the "Some" level generated a mean 1.78 ($SD = 0.78$) personalities per user (aggregating at the "Much" level yielded $M=0.44$ categories per user, which under-coding). Out of resulting 207 users who had at least 1 "Some" membership, 81 (41%) exhibited only one of these strategies. Agreement among coders was moderate (3-coders, Fleiss $\kappa = 0.561$).

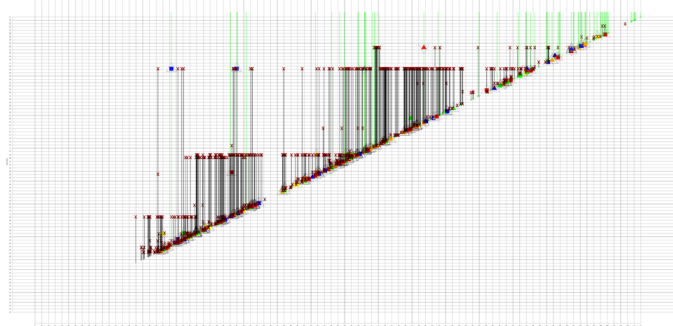
Subsequently, we computed a number of basic statistics for each group (visible in Figure 7) including the number and length of notes they created, percentage of notes they deleted, average lifetime of notes taken, number of notes per day, average number of edits per note, average frequency of use of



(a) typical “packrat”



(b) typical “minimalist”



(c) typical “sweeper”



(d) typical “revisor”

Figure 6. List-it note creation timelines. Each graph represents two years of use, extending from the lower left to the upper right. Note creations are shown as green circles along the diagonal; subsequent actions to that note are depicted vertically above this creation mark: triangles and squares for edits (of increasing/decreasing length), and ‘x’s for deletions. The lifetime of each note (time from creation to deletion) is represented as a line extending from the creation to deletion mark. Lifetimes of notes undeleted at the conclusion of the study are in green.

search, and tool use frequency. Packrats kept more, longer notes, and deleted fewer; as a result, their collections grew at an average rate of 1.06 notes/day. Minimalists’ note collections stayed a constant size, deleting notes the most vigorously, and also using List-it the most regularly (a full 33% of all days the tool was installed).

Comparing these four categories to previous PIM “personalities”, the *frequent filers* and *archivists* found by Malone, Mackay [11], Whittaker [17] and others most closely mapped to our “minimalists”. Since List-it has no explicit foldering/archiving mechanism⁵, individuals desiring to keep their lists organized and tidy (tendencies that such groups in previous studies exhibited) were likely to prune them down to only what needed to be visible at a time. Meanwhile, the earlier category of *filers* and *non-filers* most closely matched our *packrats*, who kept List-it as an extended circular file. Similarly, the periodic sweepers in our study mapped nicely to Whittaker’s “cleaner-uppers” and Abrams’s “sporadic filers” [1]. Our category of “revisers”, however, was unique to our study and may be the result of an appropriation strategy devised for people who like to have one continuous text area rather than discrete notes.

Analysis 3: Note dynamics: creation and retrieval

Creation - Creation of notes was fast. Figure 8 (a) is a distribution of seconds (up to 1 minute) of all note capture instances across participants. The median duration was 14.2s.

Search terms - Participants collectively performed 6193 keyword search queries using 3263 distinct search terms over the study period. The counts of the searches were distributed like a heavy tail; while the most frequently occurring search term (“todo”) was issued 143 times, most query terms were issued only once (median=1, M=1.9 queries). Among the top 100 terms searched for, the 15 most frequently occurring ones were note label meta-data seemingly added to facilitate retrieval, comprising words such as “todo”, “reminder”, “toread”, “tips”, “trackme”, “followup”, “tips”, “shortcuts”, “@done”, “@work”, and “@home”. The next most common terms were 14 generic categories of things, including “books”, “computer”, “flight”, followed by computer terms (3) “samba”, “web”, “url”, “mount”, “ftp”, company names (12), and names of people (3). Overall, search terms were short, with a median length of 5 characters and mean of 11.2.

How often were notes searched for? Keyword search use highly depended on the individual. Most individuals used search very infrequently; 72 (17%) never used it at all, and the mean searches per user per day over their entire use of List-it was 0.18 ($SD = 0.36$)⁶. A few participants used it fairly regularly; 7% averaged more than 1.0 searches per day over their use of the tool. The participant who used searches the most averaged 3.9 searches per day, accumulating 130 searches using 92 distinct search terms during her use of the tool.

⁵Users can easily simulate folder functionality, through saved search filters - in practice, this was rarely/never used as such

⁶To calculate this statistic, we considered only days where the user interacted with List-it at least once

style	length words/lines	adds/day	deletes/day	collection size Δ /day
<i>everyone</i> ($n = 420$)	18.0/2.11 (138.95/79.18)	1.63 (2.24)	1.15 (1.49)	0.47 (2.26)
<i>packrats</i> ($n = 165$)	25.17***/3.06 (178.30/40.12)	1.93* (1.84)	0.86* (2.08)	1.06* (2.58)
<i>minimalists</i> ($n = 201$)	13.99/1.99 (109.179/94.60)	1.33* (0.91)	1.34* (0.95)	-0.005* (0.41)
<i>sweepers</i> ($n = 39$)	15.94/1.80 (140.88/97.32)	1.27* (0.50)	1.21* (0.74)	0.07* (0.34)
<i>revisors</i> ($n = 29$)	14.06/2.64 (178.30/88.44)	0.35*** (1.8)	0.41** (2.74)	0.02* (0.21)
style	% notes kept (not deleted)	edits/note	searches/day	% days active
<i>everyone</i>	33% (47%)	0.29 (2.06)	0.17 (0.37)	27% (3%)
<i>packrats</i>	67%* (47%)	0.19*** (0.88)	0.25* (0.40)	25% (2%)
<i>minimalists</i>	13%** (33%)	0.26 (1.74)	0.10** (0.19)	33%* (4%)
<i>sweepers</i>	20%* (39%)	0.30 (5.23)	0.16 (0.33)	29.7% (4%)
<i>revisors</i>	38%* (48%)	1.48*** (6.29)	0.29 (1.06)	18%* (3%)

Figure 7. Means and SDs of characteristics of keeping behaviors of $P = 420$ users by their “keeping style” and the notes they keep. Note characteristics (length and number of edits) were tested over all notes by participants ($df = 66, 151$) using ANOVAs blocked by participant; user characteristics were tested with 1-way ANOVAs ($df = 420$). All tests rejected the null hypothesis indicating significant differences among keeping styles as follows: chars/note: $F(4, 66146)=49.69$ ($p \ll 0.001$), words/note: $F(4, 66146)=32.21$ ($p \ll 0.001$); edits/note: $F(4,66146)=297.99$ ($p \ll 0.001$); added notes/day $F(4,415)=6.16$ ($p < 0.01$); deleted notes/day $F(4,415)=2.95$ ($p < 0.05$); note collection size change/day $F(4,415)=10.41$ ($p \ll 0.001$); % notes kept $F(4, 415)=10847.48$ ($p \ll 0.001$); searches/day $F(4,415)=8.35$ ($p < 0.01$); days active $F(4,415)=5.87$ ($p < 0.01$). Results of pairwise Tukey-HSD post-hoc analysis indicated above with (*) $p \ll 0.001$, (**) $p < 0.01$, (*) $p < 0.05$ for all features that exceeded pairwise significance.**

Which users searched and who didn't? Participants who created more notes also searched more often than those who created fewer notes ($\rho = 0.11, p < 0.0001, df = 1509$). While average note collection size did not correlate significantly with the amount of searching, it did vary with strategy; minimalists searched significantly less than packrats. This was likely due to the fact that, as Analysis 2 revealed, packrats were more likely to store reference items (which needed to be quickly retrieved, a good use case for keyword search) while minimalists used List-it predominantly for memory triggers which were only effective when they were noticed - thus explicit searching for these forms was unlikely.

Which notes were retrieved? Out of all ($N=66,151$) notes in our sample, only 13,131 (19%) were ever retrieved in using keyword search. But if retrieved, they were often retrieved multiple times. Figure 8 b) displays the number of retrievals for notes retrieved at least once.

The large-set retrievals (127 notes of 65-70 retrievals, 158 notes of 70-75 retrievals, 6 notes with 75-80 retrievals each) in the histogram, were generated by 5 individuals who added textual labels (essentially tags) to each of their notes and searched for these tags repeatedly to essentially create multiple views of their notes collection. These peaks thus were created because each of these tags caused the re-retrieval of a large number of notes. The first three users used simple project or person tagging: “Sarah”, “bike”, “Wifi”. The fourth individual used tag sequences to categorize each note at multiple levels of granularity: “home - photo”, “home - entertainment - movie”, “home - music - 90.xfm monday 5/11 (...)”. These notes seemed to be a mixture of memory triggers and reference items but such roles were not distinguished by his system. The fifth individual used a mixture of types of tags to organize 273 links of found cartoons on the web. Each note a single URL each, annotated with an action (“watch later”, “add to x list”, “google X”), a priority, ratings (e.g., “LOVE LOVE LOVE”), or the name of primary

character featured in the cartoon.

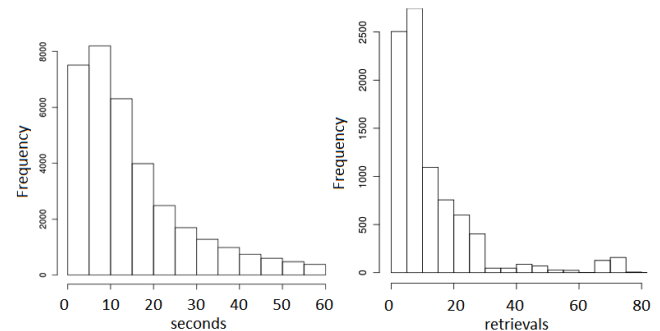


Figure 8. (a) Distribution of time to create a note (in seconds, measured from text area focused until save). $df = 42571$ instances were recorded across the 420 participants. (The 18% that took > 1 min are omitted). (b) Histogram of times a note was retrieved (for notes retrieved at least once): (median = 5, $M = 9.41, SD = 12.88, df = 13131$)

Analysis 4: Interviews

Eighteen people (12 males, 6 females) were recruited via e-mail to participate in an interview we conducted in October 2009. Ages ranged widely (18-25:3, 25-35:4, 35-50:2, 50-60:5, 65+:4); all graduated high school; 6 graduated college, and 6 had advanced degrees (master’s and doctorates). While three reported spending less than 3 hours a day on average at their computers, 11 reported spending more than 6 hours a day at a computer; thus the majority of these interviewees were all heavy computer users. Fifteen responded that they used List-it on their machine at work, while 13 had it on their home PC. We focus the discussion of responses to the question that yielded the greatest variety of responses: “If you could have one tool or feature that would make you more organized, what would it be?”

Ease and speed of capture - Eight (44%) of the responses mentioned some aspect of being able to write things down quickly and easily. Several participants expressed that any

steps that got in the way of writing something down became a deterrent. Many participants gave specific suggestions towards making capture more effective. Six participants requested direct select-and-paste features. Others mentioned wishing to be able to directly capture e-mails, web page contents and calendar events into List-it. Three asked for support for speech-to-List-it transcription from mobile phones.

Simplicity - Several emphasized that the simplicity of the tool was the primary reason they liked and trusted it. In particular, one participant, a writer, described her avoidance of other popular note-taking tools:

At first I tried using Evernote and found it too “veiled”; also too laborious to load and work with. I was looking for a note-taking program that would really seem as if I were just doing that: typing into a blank space of some sort and then going on to the next blank space.

Simplicity was especially valued by older study participants, who mentioned the sparsity of List-it’s interface and ease of use.

Reminding, task management and motivation - Many participants mentioned wanting better support for to-do lists and reminders. Several simply asked for functionality that would let them set alarms on notes, which would cause them to be shown, alerted (or text messaged) at a particular date and time, or after a certain period of time had elapsed since note creation. Three people suggested that this date and time should be automatically gleaned from text put into the note. Beyond alarms, three participants mentioned wanting specific views of their notes that would sort their notes by priority, or, more specifically, by what they had to do that day. One participant wished that List-it could remind him when he was in the process of writing something he had already written down previously.

Visibility/prominence - Closely related to reminding was visibility; many participants cited liking List-it because it was highly prominent in their browser.

One place to put it in and get it out - Several participants mentioned having a *single* place to put information regardless of *what it was* as the most important reason why they liked putting information into List-it. Several others mentioned wishing that List-it could make it possible to automatically import text from external information sources (e-mail, address books, calendar and the web) so that this information would be more easily accessed in one place.

Organization - Separate from task-related organization, several participants had recommendations for ways they’d wished List-it would group information that they had not seen in any other tool. Two such comments mentioned automatic organization, and support for pivoting hierarchies.

CONCLUSION

The purpose of this study was to examine people’s means of dealing with information scraps, a term we coined to rep-

resent the whole gamut of small pieces of information that eluded organization in digital PIM tools, from notes to-self and reminders, to statements or phrases filed for future reference. To this end, we created List-it, a micro-note tool which was flexible, easy to use, and instrumented to record in-situ interactions, to allow us to observe how people actually saved and accessed information. From this data, amassed over a period of two years, we were able to deduce the basic personal information needs which underlay the ubiquitous note-to-self.

This study revealed a number of parallels between the ways people used List-it and the findings centering on the use of paper from previous studies. For example, the ease and speed with which notes could be made led List-it to be used to store many short notes (one or two word reminders) in under 10 seconds (Analysis 3), rivaling the time it took to write something down on a paper Post-It. List-it’s visible position in the browser lent it to be used for reminders and quick reference items for use during browsing (mentioned in interviews, Analysis 4), much as Post-Its were used to place information in the way of something so it was found when needed [2]. Like paper, List-it was used for thinking things through – brainstorming, writing drafts (e.g., e-mails or blog posts), devising plans (e.g., itineraries and planning vacations) and problem solving (e.g., keeping track of possible solutions). This process of thinking through writing was made possible by the freeform nature of notes taken in List-it, which supported the natural documentation of ideas in the forms that they occurred. In contrast, this was difficult to execute with most structured PIM tools because of the constraints placed on the kinds of information and forms these tools could handle.

Like a paper diary, we found that people kept anything and everything in List-it; the lack of any preconceived notion of what did or did not belong in List-it made it a single place where everything could be stored and kept: ephemera, information of immediate need, possible later use, or that may never be actually needed. As a result, our study participants used List-it for keeping ideas, thoughts, archiving snippets from the Web, and chronicling things that they had done or experienced– just as they might have done in a paper journal.

The absence of organizational requirements imposed by the tool also contributed to List-it’s usefulness, because it freed the user from having to think about what kind of notes they were taking, and avoided forcing users to pigeonhole notes into any one particular form. Analysis 1 revealed that the note forms and roles in List-it were only loosely correlated, in that notes often served multiple roles fluidly and simultaneously - for example, notes taken at an event could simultaneously serve as a reminder of something to do (a memory trigger), a reference for future access, and a memento of the experience. Structured PIM tools, in contrast, strongly associated fixed sets of affordances and functionality with particular forms (e.g., alarm reminder functionality is available only for calendar events), which may be imposing undue restrictions on what users can do with their information. Moreover, while most structured PIM tools force discrete items to

be stored separately, we found that users naturally mixed information forms in their notes, and embedded forms in other forms, (by including bookmarks in a to-do item, or contact information in a calendar appointment, for example), which allowed them to keep associated items naturally together. Finally, the lack of organizational features such as folders in List-it did not deter individuals, but rather inspired them to devise their own solutions, as revealed in Analysis 3, such as by textually tagging notes, and appropriating List-it's search functions to create quickly-toggleable views of sets of tags as needed.

An open question that resulted from Analysis 2 was whether and how PIM tools should support inherent differences in the ways people preferred to manage their information archives, whether they be packrats, minimalists, sweepers, etc. These differences were easily recognizable in List-it usage patterns and note collections, just as previous studies had found in paper, e-mail and web bookmark organization, etc. Examining the needs of each of these personalities in greater detail could lend insight towards making tools more effective. The strength of List-it as it stands is that it accommodates all of these individual styles of note-taking.

In summary, our study revealed that supporting the quick and convenient capture and access of arbitrary information enabled digital micro-notes to be used in much the same ways that paper-based information scraps were – for reminding, reference, external cognition, journaling and the archiving of items of personal value. Thus, while previous personal information studies have argued that paper and pen would remain more versatile and convenient for note-taking than digital tools [14]; such affordances are finally enabling digital PIM tools to challenge the age-old supremacy of the pen, paper and Post-It.

ACKNOWLEDGEMENTS

We thank the study volunteers for their participation, Michael Bernstein, Greg Vargas, Shauna VanKleek, Kat Fang, Nigel Shadbolt, for their input and expertise, and Nokia Research, the National Science Foundation, MIT CSAIL, and the University of Southampton for support and sponsorship.

REFERENCES

1. Abrams, D., Baecker, R., and Chignell, M. Information archiving with bookmarks: personal web space construction and organization. In *Proc. CHI '98*, ACM Press (1998).
2. Bellotti, V., Dalal, B., Good, N., Flynn, P., Bobrow, D. G., and Ducheneaut, N. What a to-do: studies of task management towards the design of a personal task list manager. In *Proc. CHI '04*, ACM Press (2004).
3. Bernstein, M., Van Kleek, M., Karger, D., and schraefel, m. Information scraps: How and why information eludes our personal information management tools. *ACM TOIS* 26, 4 (2008), 1–46.
4. Campbell, C., and Maglio, P. Supporting notable information in office work. In *CHI '03 extended abstracts on Human factors in computing systems*, CHI '03, ACM (New York, NY, USA, 2003), 902–903.
5. Gwizdka, J., Louie, J., and Fox, M. S. Een: a pen-based electronic notebook for unintrusive acquisition of engineering design knowledge. In *Proc. WET-ICE'96, WET-ICE '96*, IEEE Computer Society (Washington, DC, USA, 1996), 40–.
6. Kalnikaitė, V., and Whittaker, S. Software or wetware?: discovering when and why people use digital prosthetic memory. In *Proc. CHI '07*, ACM Press (2007).
7. Khan, F. A survey of note-taking practices. Tech. Rep. HPL-93-107, HP Laboratories Bristol, December 1993.
8. Lansdale, M. W. The psychology of personal information management. *Appl Ergon* (Mar 1988).
9. Liao, C., Guimbretière, F., Hinckley, K., and Hollan, J. Papiercraft: A gesture-based command system for interactive paper. *ACM TOCHI* 14 (January 2008), 18:1–18:27.
10. Lin, M., Lutters, W. G., and Kim, T. S. Understanding the micronote lifecycle: improving mobile support for informal note taking. In *Proc. CHI '04*, ACM Press (2004).
11. Mackay, W. E. Diversity in the use of electronic mail: a preliminary inquiry. *ACM TOIS* 6, 4 (1988), 380–397.
12. Mackay, W. E., Pothier, G., Letondal, C., Bøegh, K., and Sørensen, H. E. The missing link: augmenting biology laboratory notebooks. In *Proc. UIST '02, UIST '02*, ACM (New York, NY, USA, 2002), 41–50.
13. Malone, T. W. How do people organize their desks?: Implications for the design of office information systems. *ACM TOIS* (1983).
14. Sellen, A. J., and Harper, R. H. *The Myth of the Paperless Office*. MIT Press, Cambridge, MA, USA, 2003.
15. Van Kleek, M. G., Bernstein, M., Panovich, K., Vargas, G. G., Karger, D. R., and Schraefel, M. Note to self: examining personal information keeping in a lightweight note-taking tool. In *Proc. CHI '09*, ACM Press (New York, NY, USA, 2009), 1477–1480.
16. Van Kleek, M. G., Bernstein, M., Panovich, K., Vargas, G. G., Karger, D. R., and schraefel, m. Note to self: examining personal information keeping in a lightweight note-taking tool. In *Proc. CHI '09*, ACM Press (2009).
17. Whittaker, S., and Sidner, C. Email overload: exploring personal information management of email. In *Proc. CHI '96*, ACM Press (1996), 124–130.
18. Yeh, R., Liao, C., Klemmer, S., Guimbretière, F., Lee, B., Kakaradov, B., Stamberger, J., and Paepcke, A. Butterflynet: a mobile capture and access system for field biology research. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*, CHI '06, ACM (New York, NY, USA, 2006), 571–580.