A Diary Study of Task Switching and Interruptions

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ABSTRACT
We report on a diary study of the activities of information workers aimed at characterizing how people interleave multiple tasks amidst interruptions. The week-long study revealed the type and complexity of activities performed, the nature of the interruptions experienced, and the difficulty of shifting among numerous tasks. We present key findings from the diary study and discuss implications of the findings. Finally, we describe promising directions in the design of software tools for task management, motivated by the findings.

Author Keywords
Multitasking, diary study, task switching, interruptions, information worker, office and workplace.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI).

INTRODUCTION

Information workers often interleave multiple projects and tasks. Although workers may switch among tasks in a self-guided manner, a significant portion of task switching is caused by external interruptions. We have sought to understand the influence of interruptions on task switching for information workers. Beyond understanding the costs of interruption, characterizing the density and nature of interruptions—and user's experiences with recovery from interruptions—promises to provide valuable guidance for designing user interface tools that can assist users' recovery from interruptions.

We report on a diary study of task switching and interruptions over the course of a week. The study revealed that participants performed significant amounts of task switching and encountered numerous interruptions. We found that the reinstatement of complex, long-term projects is poorly supported by current software systems. To address several key problems with recovery from interruptions, we discuss several designs for supporting task switching and recovery that were motivated by the results of the study. The contributions of this research include a characterization of office workers' multitasking behaviours over a week, and the formulation of designs for software tools that promise to enhance productivity.

RELATED WORK

Information workers are often governed by multiple tasks and activities that they must remember to perform, often in parallel or in rapid succession. This list of things to be done typically spans multiple media types, such as sticky notes, electronic to-do lists, calendar entries, and the like. A failure to remember a task that needs to be performed in the future has been referred to as a *prospective memory failure* [10]. Beyond simply remembering, successful prospective memory requires recall at the appropriate moment in time. Increasing numbers of interruptions and items to be remembered can wreak havoc with both aspects of prospective memory, and hence, can reduce an office worker's daily productivity.

A growing body of work has already shown prospective memory failures to be a significant problem for information workers [5, 28, 33, 35]. Researchers have found that users devise unique strategies for remembering in attempts to minimize prospective memory failures [3, 13, 18], such as emailing reminders to themselves or even creating web pages that encode a set of task reminders. Nevertheless, very little is known about why those mechanisms are useful for recalling tasks or how technology might be better designed to help users reduce forgetting the details of important information throughout their busy lives.

Interruptions of tasks are one of the most frequently cited reasons for prospective memory failures during the work day [28]. A number of research efforts have been aimed at better understanding the effects of interruptions during computing tasks (*e.g.,* [4, 12, 15, 24, 26, 28]). This growing body of research highlights the difficulty that users have with returning to disrupted tasks following an interruption, such as an instant message, phone call, or engagement by a colleague. But just how many interruptions do typical office workers experience during a given day? One group of researchers studied 29 hours of videotape of mobile professionals and found that participants in their study experienced, on average, just over four interruptions per hour [28]. The researchers noted that subjects found interruptions valuable at times, but generally characterized them as a nuisance. The study showed that, 40% of the time, the disrupted task was not resumed immediately following the interruption. It is presumed that the worker does not return to the primary task right away either because some component of the task or surrounding context has been forgotten, or because it has become too difficult in some way to resume given the competing demands of the distraction.

Other related work has focused on designs and prototypes of tools for assisting with recall. For example, researchers have found that a navigable video log of a computer screen over a day of activities can be used as a memory-jogging tool. Review of such video logs has been shown to be especially beneficial to users after longer periods of elapsed time [5, 22]. Although video diary tools may be valuable, they require time for review—time that busy multitasking information workers may not have to spare.

Recently, several researchers have attempted to create user-interface designs that help computer users with remembering items in the short term. In one study, investigators found that providing a history of recent actions with explanations was useful for error recovery during software development [30]. In an application developed for users of mobile devices [21], users' physical locations, workstation activities, file exchanges, printing, phone calls, email, and colleagues present at meetings, etc. are continuously logged. The system later displays these events and allows the user to filter content on key event details, like time, person, place, etc. The Remembrance Agent [31] is an automatic text retrieval system based on a user's current location. The system returns information about other users or items available in the system based on the user location and the relatedness of the items. Rekimoto's Time-Machine Computing [29] provides access to desktop contents along a time line, and generates visualizations of content based on frequency of access. Other systems, such as Cyberminder [8], Memory Glasses [7], Lifestreams [11], have been designed to support users' memory in real time while computing with time-centric visualizations.

DIARY STUDY

Given the paucity of empirical studies of the usefulness of tools that have been proposed for assisting with task recovery, it remains unclear to what extent these kinds of prosthetics actually solve the real needs of busy information workers. Thus, we undertook a diary study to explore the extent to which these kinds of systems were needed by knowledge workers. Diary studies have high ecological value as they are carried out *in situ*, in the users' real environments. On the negative side, diary studies suffer from the problem that they are tedious for the recorder and they can invoke a "Heisenberg-style" challenge: the process of observing may influence the observations in that journaling tends to add to the interruption of the flow of daily events. Despite these problems, we felt it was overall beneficial to start from ecologically valid data that might reveal interesting patterns of multitasking and interruption, while realizing that there would be imperfections with regard to comprehensiveness and accuracy. Beyond examining diary logs, we worked to capture users' personal descriptions of their work. We asked users to label their tasks when they switched to them, with an eye toward discovering the different conceptual levels of task types that users might deem important enough to write down. We were careful not to instruct the participants about what they should consider tasks to be—we asked them to define them for us.

After collecting and analyzing the diary data from our participants, we review designs and evaluations of prototype task-management tools that were motivated by challenges identified in the study. The emphasis and contribution of this paper is on providing the HCI community with additional insights about the degree and types of multitasking and interruption that information workers experience over a work week, in order to guide the development of software tools that can assist the workers with multitasking.

Method

Eleven experienced Microsoft Windows™ users (3 female) participated in the study. All of the participants reported multitasking among more than three major projects or tasks (as defined by the users) on the job, and all were experienced office software users as evaluated by an internal, validated questionnaire. Participants' occupations spanned a spectrum of domains, including a stock broker, professor of Computer Science, web designer, software developer, boat salesman, and network administrator. The participants' ages ranged from 25 to 50 years of age.

A Microsoft Excel XP™ spreadsheet, with worksheets for each day of the week and another for participant instructions, were created with columns for each tracked parameter. Columns were created for *Time of Task Start*, *Difficulty Switching to the Task*, *What Documents Were Included in the Task*, *What Was Forgotten If Anything*, *Comments*, and the *Number of Interruptions Experienced* and the users' task descriptions. We include as an example a spreadsheet, for one participant in Figure 1.

We were interested to learn how users defined tasks, and in understanding personal variation in the granularity at which tasks are defined. A review of the different participants' spreadsheets revealed that, over the same span of time, different participants in the study chose to encode "task switches" at different levels of detail. In addition, the number of task switches appeared to be influenced by the participants' occupations. The participant associated with the log in Figure 1 was a stock broker, and his day consisted of a large number of client calls—each of which he considered a separate task. Such variation in how people define tasks suggests that designers of tools that support task recovery will need to provide users with flexibility in terms of the level of detail and numbers of tasks that the users may wish to use to represent their projects.

Two experimenters coded all of the users' first day diaries to ensure cross-experimenter validation and to test the rich coding scheme that had been developed. The codes were derived from reading over the users' entries and partitioning them into recurring categories. We found that the experimenters were at 98% agreement in the use of the codes for the first day following an initial phase of derivation. Policies were developed for disagreements in coding applications, and these policies were executed for the remaining diaries. The experimenters split the remaining four days of diary coding but continued to consult with each other to resolve in a satisfactory manner the few ambiguous task entries that were noted.

	A	B	C	D	E	F	G	H	I	J	L
1	Time (HH:MM	Project/Task Descript	Application or D	Priorit	What caused the	Diffic	What docs/data needed to be found?	On T	# of Interruptions	Time completed	Time On Task
2	5:05 AM	check email	outlook	hi	n/a	lo	n/a	yes	0	8:31 AM	3:26:00
3	5:31 AM	daily task check	outlook tasks	hi	check tasks	lo	n/a	yes	0	5:33 AM	0:02:00
4	5:33 AM	look up phone numbe	outlook contact	hi	phone call	lo	phone number	yes	0	5:34 AM	0:01:00
5	5:35 AM	client call	outlook contact	hi	phone call	lo	n/a	yes	0	5:39 AM	0:04:00
6	5:40 AM	spreadsheet for client	excel	med	on task list	lo	saved excel spreadsheet	yes	5	11:07 AM	5:27:00
7	5:50 AM	answering email	outlook	hi	n/a	lo	n/a	no	0	6:01 AM	0:11:00
8	6:05 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	6:07 AM	0:02:00
9	6:11 AM	add task items	outlook tasks	hi	phone call	lo	outlook tasks	no	0	6:15 AM	0:04:00
10	6:17 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	yes	0	6:27 AM	0:10:00
11	6:28 AM	look up phone numbe	outlook contact	hi	call client	lo	phone number	no	0	6:28 AM	0:00:00
12	6:32 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	6:40 AM	0:08:00
13	6:44 AM	account number look	outlook contact	hi	needed client ac	lo	account number	yes	0	6:44 AM	0:00:00
14	6:48 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	6:57 AM	0:09:00
15	7:06 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	7:20 AM	0:14:00
16	7:30 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	7:37 AM	0:07:00
17	7:40 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	7:43 AM	0:03:00
18	7:50 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	8:00 AM	0:10:00
19	8:15 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	8:20 AM	0:05:00
20	8:30 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	8:40 AM	0:10:00
21	8:44 AM	look up email addres	outlook contact	hi	client message	lo	new email	no	0	8:45 AM	0:01:00
22	9:01 AM	sending email	outlook	hi	client message	lo	outlook email	no	0	9:03 AM	0:02:00
23	9:11 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	9:15 AM	0:04:00
24	9:27 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	9:40 AM	0:13:00
25	9:42 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	9:50 AM	0:08:00
26	9:57 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	10:05 AM	0:08:00
27	10:15 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	10:20 AM	0:05:00
28	10:21 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	10:25 AM	0:04:00
29	10:27 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	10:33 AM	0:06:00
30	10:34 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	10:35 AM	0:01:00
31	10:36 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	10:37 AM	0:01:00
32	10:37 AM	adding calendar item	outlook calenda	hi	client appointme	lo	outlook calendar	yes	0	10:39 AM	0:02:00
33	10:45 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	10:50 AM	0:05:00
34	10:55 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	11:10 AM	0:15:00
36	11:15 AM	client call	outlook contact	hi	phone call	lo	outlook contact enter data into textbox	no	0	11:17 AM	0:02:00

Figure 1. Partial diary for subject MS over a 6 hour period.

Results

Baseline Survey. User responses to a baseline survey showed that the workers perceived computers as powerful tools that enhanced their productivity. In general, the participants believed that their computer files were well organized and that they did not have significant trouble finding files or information on their computers. We also found that users in the study included an equal mix of workers who described their work as primarily deadline driven and those who were not driven by deadlines (*i.e.*, they chose what projects to work on and when). In addition, we noted that the participants were proud of their ability to multitask, and they reported feeling that multitasking brought fun and variety to their work.

Diary Analyses. We performed several analyses on the diary data. First, frequency counts of the number of diary entries for each dependent measure were calculated. In addition, subjective ratings of task-switch difficulty were also collected for each diary entry. Also, the amount of time spent on the tasks was obtained for each entry. For each of these statistics, a spreadsheet was calculated for each participant by day of week. Most statistics were then collapsed across days in order to build an overall picture of how participants switched among tasks over the week. The data was subjected to multivariate logistical regression with each user's task switch entry included as input. Statistical analyses of all of these metrics are presented in the next sections.

Types of Tasks. One outlier participant was removed from the rest of the analyses because the subject did not switch among more than two tasks on any given day of the week (therefore not meeting our criteria for participation). For the ten remaining participants, we examined the granularity at which different users defined a task switch. Recalling another specific example from the diaries, task entries appeared as follows:

BH (spanning 6 hours):

1. Daily Schedule Preparation
2. Synch PocketPC
3. Check Internet Email
4. Check and respond to email
5. Matlab coding
6. Create Charts for Meeting
7. Edit Word documents for meeting
8. Meeting
9. Matlab coding

For all of our participants, "email" was clearly considered a task that had to be dealt with repeatedly throughout the day. In fact, it often appeared that anything else that participants listed in their diaries was their core work, since they spent so much time in email. Users tended to use generic terms to describe their tasks, such as "create/edit web pages," "annual performance review," and "work on PPT slides" instead of using more specific, meaningful keywords to describe their activities. We found workers' use of simple labels to describe their activities interesting, as it appears feasible to use event logging software to similarly annotate tasks with simple terms. As a side note, more descriptive information was often written as annotations under the column header, "What caused the task switch?" In that column, users would list things such as, "Need to prepare for meeting with supervisor," "scheduled quarterly meeting," "primary job responsibility," or "time to go to the gym." We are not sure at this point why users chose to write down more meaningful information about the basis for the task switch in comparison to their actual task descriptors, but such information might provide value in applications and operating systems that seek to acquire and leverage metadata from users about data and tasks. The diary data suggests that users might enter information that is somewhat abstract when they are prompted with questions about tasks.

A further breakdown analysis of the participants' reported task types and their frequencies was performed. In total, 45% of the reported tasks in participants' diaries were described as project-related or routine tasks that comprised the participants' jobs. We found that 23% of the tasks reported could best be described as "email." Perhaps more interestingly, we discovered that participants reported "task tracking" as comprising 13% of their reported task switches. Our users went to great lengths to track their tasks, including the use of personal digital assistants, working to mirror files and drives, and burning CDs of their information before leaving work in the evenings. The frequencies of the types of tasks are shown in Figure 2.

For most tasks, participants reported an average of 1.75 documents being employed in the activity. This number is a conservative estimate of the amount of material actually needed for a task, as some users did not report what documents they included for a given task switch, and some only used abbreviations (*e.g.,* "several *.doc and *.xls files" was often an entry a participant would provide in the diary). In these cases, per our coding conventions, we registered the most conservative estimate of the number of documents for that task–2. In addition, users reported an average of 0.7 interruptions per task, almost a one-to-one interruption to task ratio! This should also be taken as a conservative estimate, because several users would simply indicate that they had received "multiple" interruptions during a task,

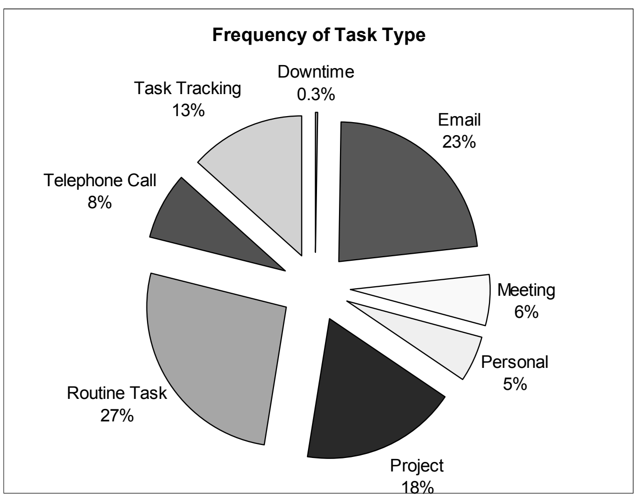

Figure 2. Frequency of diary entries for various task types. Routine tasks, reading email, and project-related work comprised the majority of our users' days.

wherein the experimenter could only assume more than one (*e.g.*, 2). Finally, on average, our participants reported that most task switching was relatively easy (average rating = 1.4, on a difficulty rating scale where 1=low, 2=medium and 3=high). This is understandable, given that email was almost always rated as relatively easy to switch to, and that email comprised approximately one quarter of the entries across all diaries. Most tasks were rated as "high priority" on average. In other words, our participants indicated that what they mostly worked on during the course of a day was important to them and/or their organization or clients.

Reported task lengths averaged 53 minutes, with a large standard deviation of 90.9 minutes. The distribution of task lengths was highly negatively skewed, with the majority of the tasks reported being shorter than the average length. However, several tasks were reported that lasted throughout the course of the work week.

Task Shift Initiators. Next, we analyzed the frequencies of different kinds of task switches. We found that the largest category of task switches (40%) were self initiated—a clear indication that our users were typical information workers that handled their own schedules to a certain degree. 19% of the task switches were simply moving on to a new task that was on a to-do list that the user maintained in either a digital or paper format. Telephone calls prompted 14% of the reported task switches, while meetings and appointment reminders prompted another 10%. Deadlines and emergencies accounted for only 3% of the reported task switches, despite the self-reported reliance upon deadlines by a number of the participants. This could again indicate that our participants preferred to handle their own schedule to a large degree, despite looming deadlines, so as to maintain maximal flexibility. Email content prompted task switches in 3% of the reported cases, and a new information need or request from a colleague or client prompted another 3%. These data are shown in Figure 3.

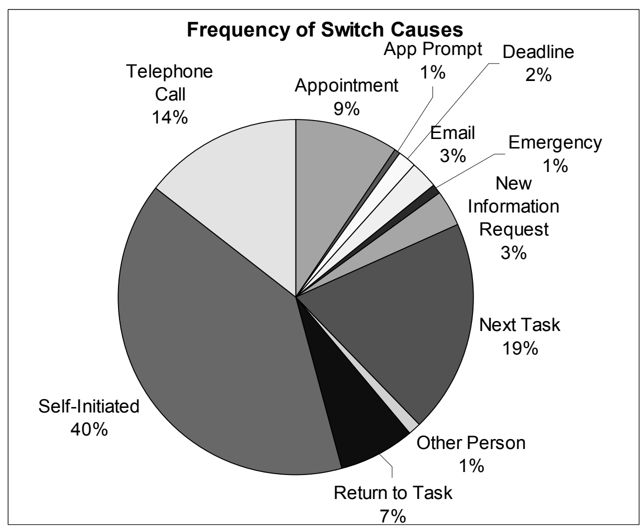

Figure 3. The frequency of diary entries for the kinds of events that instigated task switches. For our sample, users chose when to switch tasks or worked off a to-do list a majority of the time.

Difficulty Task Switching. Subjects reported that more complex tasks, especially those that lasted longer and included more documents, were more difficult to switch to. Tasks that required "returning to" after an interruption were rated significantly more difficult to switch to than others, F(1,497)= 8.453, p<.001, as shown in Figure 4.

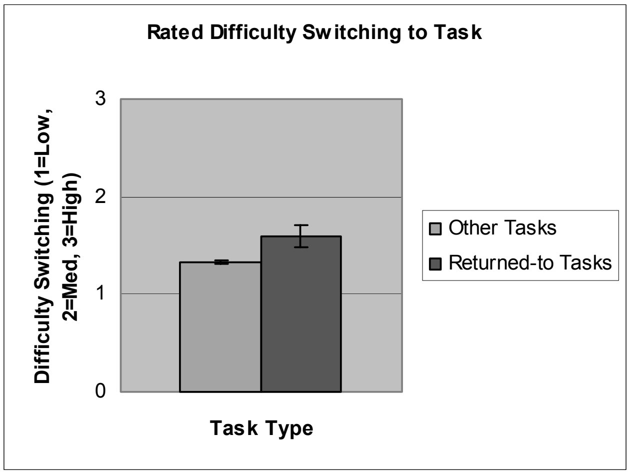

Figure 4. Average rated difficulty of switching to returned-to tasks v. other tasks.

The *returned-to* tasks were over twice as long as those tasks described as more routine, shorter-term projects (average task length = 120 minutes v. 45 minutes, respectively), F(1,494)= 23.95, p<.001, as can be seen in Figure 5. On average, returned-to tasks comprised 4.5 hours out of a 40 hour work week, or 11.25% of a user's work week.

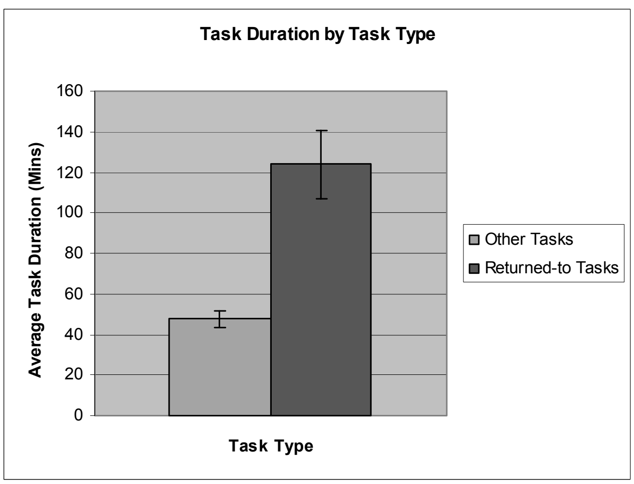

Figure 5. Returned-to tasks are significantly longer in duration than other tasks.

In addition, returned-to tasks required significantly more documents, on average, than other tasks (average 2.5 v. 1.6 documents, respectively), F(1,497)=13.8, p<.001, as is shown in Figure 6. Again, these estimates of the number of documents comprising a user's task, both short- and long-term in nature, are conservative due to the users' tendency toward short-hand diary entries.

Finally, and not surprisingly, returned-to tasks experienced significantly more interruptions than did other activities (1.5 interruptions, on average, v. 0.7, respectively), F(1,497)= 10.62, p=.001. These findings are shown in Figure 7.

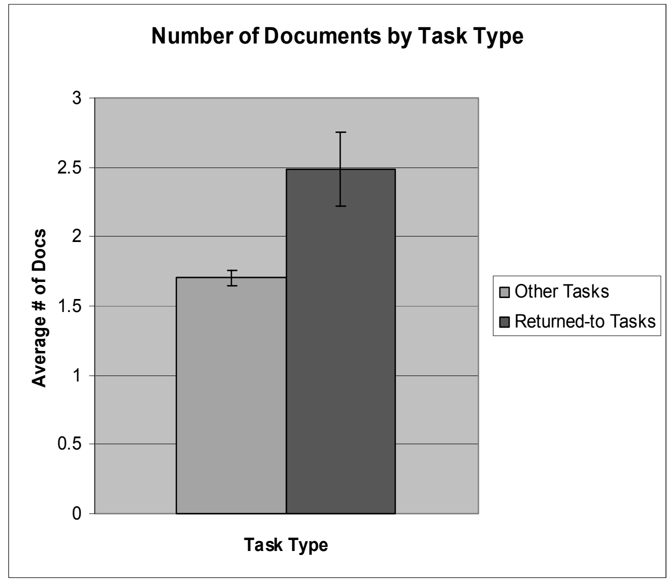

Figure 6. Returned-to tasks involve significantly more documents than other tasks.

Returned-to tasks tend to experience more interruptions because of their longer length. Research on the harmful effects of interruptions (e.g., [4], [13], [24], [26]) suggests that interruption-based prospective memory failure and productivity loss may be greater problem for these key, long-term projects.

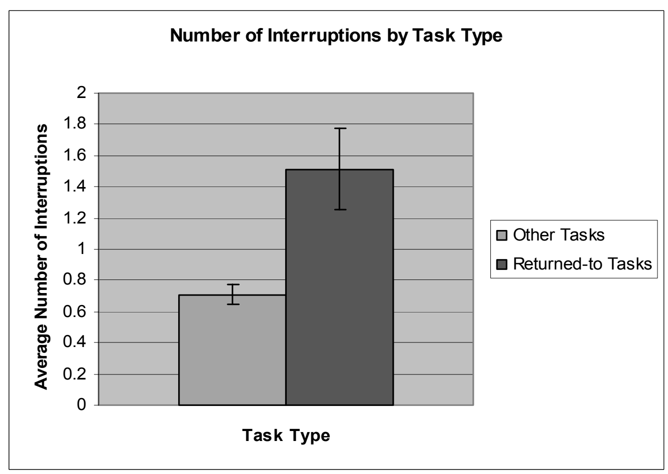

Figure 7. Returned-to tasks are interrupted significantly more often than other tasks.

STUDY DISCUSSION

Overall, we found that information workers switch among tasks a significant number of times during their work week. Participants in our study reported an average of 50 task shifts over the week. Their diaries demonstrated that returned-to projects were more complex, on average, than shorter-term activities. These key projects were significantly lengthier in duration, required significantly more documents, were interrupted more, and experienced more revisits by the user after interludes. These critical projects were also rated significantly harder to return to than shorter-term projects. Returned-to tasks were over twice as long as other tasks, accounting for over 11% of a user's total work week, on average. We found that reacquiring such tasks is not well supported in the software our participants were using, and their diaries included comments on this.

The key findings gleaned from the diary study, as well as explicit comments from participants, shaped our pursuit of designs for user interface tools that might better assist users with task switching. The results and comments especially call out the need for software support to ease the challenge of switching back to all projects, but especially to recovering long-lived projects after interruptions.

The design ideas most frequently offered by the participants revolved around creating new tools for reminding, including the potential value of cross-application project and to-do list tracking. Participants commented explicitly that better reminders would help them get back on tasks more quickly. Such tools would likely grow in value as tasks grow in duration, given the increases in the number of interruptions with project duration, and, more generally, the overall toll on retrospective memory for task content and goals observed with the passage of time [5]. In one approach to tools for tracking, productivity software applications could be designed to maintain project-specific state (*e.g.,* re-establishing the layout of multiple windows, and bringing users back to where they were at the interruption), and to provide better reminders (both prospective and retrospective), better summary views of computer work over time, and means for filtering tasks by project. Currently supported software reminding tools such as meeting announcements and to-do list reminders could be extended in that they could be made more *project-specific*, as opposed to *application-specific*, as our participants pointed out in their diaries. Also, as task switches were often prompted by phone calls, email, or personal requests, improved integration across applications (*e.g.,* the phone, email, web services, instant messaging, etc.) could benefit users' multitasking and recovery.

The development of tools for easing the reinstatement of context and associated resources appears to be a significant opportunity area. Some users, resonating with entries across many of the diaries, suggested that a form of auto-categorization of their task-related documents across applications would help them when returning to projects. Tools providing automated or manual coalescence of resources associated with a project could minimize the cost of returning to a long-term project. Such tools would likely assist users with storing and recalling sets of applications and documents, including the physical layout of files on a display.

These results, ideas and comments provide guidance for designing tools for reminding and reinstating resources for projects. We believe that such innovations promise to increase worker satisfaction and efficiency by better supporting task switching and recovery from interruption. We have focused initially on methods that can preserve and recreate multiple resources representing the state of a project over time.

INITIAL PROTOTYPE DIRECTIONS AND IMPLICATIONS

Guided by the concepts derived from users, we have focused on designs that hinge on the use of lightweight, temporal cues, such as the state of a user's desktop at various times throughout a day [16]. We are also building support for context-aware, project-based visualizations and task switching, in a similar vein to the work of [1, 2, 6, 9, 14, 20, 23, 25, 32]. An initial prototype, the GroupBar, provides users with the ability to organize project-related documents, email and other windows together in the Windows XP taskbar. GroupBar has been recently described elsewhere [34]. We shall review key properties of the tool here to emphasize how our empirical work inspired the design efforts.

Project support with GroupBar is afforded by allowing the user to drag and drop taskbar "tiles" on top of each other, forming a group of items in the bar that can then be operated on as a unit. Inspired by past work in the area of windows management (e.g., [17, 19, 27]), GroupBar also provides support for windows management and task layout; once the user lays out their work in a preferred configuration, GroupBar remembers and "rehydrates" these layouts regardless of whether or not the windows and/or applications are currently open. Based on the diary study findings, this relief from the mechanical aspects of having to tediously retrieve and arrange windows promises to save users time when multitasking and task switching. To offer users further support for recovery, GroupBar can also suggest potential layouts to the user based on the display configuration (*i.e.,* a tiled view of the required documents and windows that respects the user's monitor bezels, resolution, number of monitors or other settings). User studies with the GroupBar [34] revealed that knowledge workers appreciated these sorts of tools, and we were inspired to design additional visualizations that offer general support for multitasking across different display sizes and configurations. A fragment of the groupbar prototype design is shown in Figure 8.

Given users' needs for not only understanding what they were doing before an interruption, but also what important tasks are looming in order to better plan their time, we are exploring a range of designs, spanning a spectrum of complexity from relatively simple online to-do lists to more advanced timeline-based visualizations of projects. Easy-to-use to-do lists and reminders structured on a per task basis will likely provide value to the end user, based on the data from this study. On the more advanced methods, there is opportunity for building meaningful visualizations automatically by encoding and abstracting users' computing events over time, via the use of such analytical methods as those employed in [6]. In pursuit of such visualizations, we have developed an event recorder, and are currently analyzing the data from a set of office workers at our organization. We hope to be able to identify useful patterns in the usage data that might assist users in reviewing or reinstating task contexts. In summary, guided by the data obtained from the diary study, we seek to understand the potential benefits from the use of simple and more advanced tools, iterate their designs over time, and report on our progress using both controlled laboratory and *in situ* research methods.

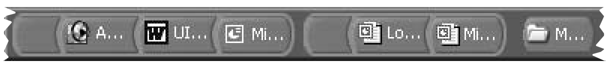

Figure 8: Fragment of GroupBar in its horizontal form factor.

CONCLUSION

We reported on an *in situ* diary study that we undertook to characterize the amount of task switching and interruptions experienced by typical knowledge workers over the course of a work week. We presented the results of the study, and provided an analysis of the challenges that users have with switching among tasks. The set of results shows that task complexity, task duration, length of absence, number of interruptions, and task type influence the perceived difficulty of switching back to tasks. Specifically, complex, "returned-to" tasks comprise a significant portion of an information worker's week, but reacquiring such tasks is considered difficult by users.

We undertook the study to identify challenges and to seek additional guidance for designing supportive user interface tools that might reduce the difficulty of multitasking. It is clear that more can be done within the operating system and software applications to help users multitask and recover from task interruptions, hence potentially increasing productivity. The findings suggest that methods for capturing and remembering representations of tasks may be valuable in both reminding users about suspended tasks, and in assisting users to switch among the tasks. Examples of such methods include time-centric visualizations and tools that can record, and reconfigure upon demand, the layout of multiple windows of content and applications that comprise a task. We reviewed efforts on the latter centering on a re-design of the Windows XP taskbar to provide users with the ability to record and reconfigure the layout of windows associated with a task.

In summary, the diary results provided us with useful guidance for formulating designs for task-management tools. We are in the process of characterizing and refining designs via longitudinal user studies. We believe that continuing research on task recovery will yield new kinds of project management tools that promise to enhance the productivity and satisfaction of information workers.

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