Using Physical-Social Interactions to Support Information Re-finding

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Abstract

A dominant way in which we organize our world is through social interactions. Much research has made use of social context as a way to support information storage and re-finding. However, they tend to focus only on the virtual side of sociality, and downplay the role of physicality in social interaction. In our research, we investigate how a person's physical-social interactions, in the form of co-presence, can be employed to support digital information management. We designed and implemented a system based on this concept and evaluated it in three two-month long case studies. Our system associates digital information used in social situations with co-present individuals through the use of automatic or manual tagging. Our findings showed that although the three participants varied greatly in their information filing and information use strategies, they all accessed digital information using people or groups of people, thereby supporting our initial premise. However, we found that the need to use digital information during social interactions arises only when there is a shared focus in the form of, for example, a large display, or when there is a social purpose for the information, for instance to share it with other meeting members at a later time. Our observations suggest the need for further research and innovation in technology affordances for real-time information use in physical-social interactions.

Keywords
personal information management; re-finding; physical-social interactions; context; tagging

ACM Classification Keywords
H.5.2. [**Information interfaces and presentation: User Interfaces**]: Graphical user interfaces.

Introduction
Humans are physical and intrinsically social. We organize our worlds around our social interactions. As the volume of information that we use daily grows, our social interactions may act as an intuitive handle to support how we think of and access information. Previous research on socially-based information re-finding has focused on the virtual side of sociality, such as using sender/receiver filtering in email. This considers only 'sociality in the cloud', and downplays the role of physicality in social interaction. Our research addresses how a person's physical-social world may be connected to their ever growing digital-information world. More specifically, we ask the following research question: How can our physical-social activity be employed to support our digital information management needs? We posit that associating a user's social world with his/her digital information may provide a natural way for organizing and re-finding files. In this paper, we define 'physical-social interaction' as co-present interaction among individuals. To explore this research question, we designed a system that connects physical-social interaction with one's use of information and evaluated this in extended-use case studies with three individuals.

This paper discusses the related literature that uses one's social interaction context to support information re-finding, describes a prototype system that serves as a testbed for our investigation, and then discusses results from our case studies.

Information Re-finding Through Social Context
Research in supporting information filing and re-finding [15, 2, 20, 12] have already impacted the way we think about information access. Modern operating systems allow users to organize and re-find information using many contextual keys such as timestamps, content, custom tags [4], and origin (e.g., a website). With the growth of mobile computing, tags can include the location of where information is encountered or encoded (i.e., geo-tagging, -caching, -blogging, etc.) These contextual keys enable users to use a step-by-step approach to re-find a piece of information, a process called *orienteering* by Teevan et al. [18]. This orienteering behavior was also observed in the use of the "*Stuff I've Seen*" application [7] and in re-finding information on the web [5]. Our research adds a new contextual key based on *physical-social interactions*.

Currently, re-finding using the context of social interactions is limited to information shared virtually in communications tools such as email. Both the ContactMap [19] and SNARF [10] applications, for example, support information tasks by allowing users to think in terms of the people and groups they interact with in email. This technique allows the user to perform tasks for managing workflows, projects and goals more easily. Elsweiler et al.'s study on human memory in email shows that sender information is one dominant way by which users remember their emails [8]. Such research addresses what we have termed 'sociality in the cloud' as an information index. While we focus on using the context of physical-social interactions for information re-finding, our system does include sender/receiver information for e-mail

and attachment re-finding. This allows us to also support virtual interactions.

System Design and Implementation

Our research question elicited four core requirements for our system:

1. The physical-social interactions of the user need to be tracked;
2. The user's information-related activities and the use of 'information objects' must be tracked;
3. User information objects should be tagged based on the overlap of the user's social and information interactions; and,
4. The physical context of the social interactions should be used for re-finding information.

We accomplish these four requirements by using a list of objects called *social orbits*. The user configures these objects and then uses them to tag and re-find their information.

Configuring Social Orbits

Social orbits are similar to Facebook's groups and Google+'s circles. This list of social orbits is the user's ego-centric network [1] where each social orbit is made up of one or more people that the user interacts with in some way. People in a user's network can belong to more than one social orbit. By default each person added to the list is also a single-person social orbit. The names of each social orbit are used for tagging the user's information objects. During a re-finding task, the user can use the person or group name they created to *orienteer* and browse for a piece of information on their computer.

The automatic discovery of one's social network has been the subject of much research in information mining [11, 14]. However, we are concerned with the *use* of social interactions as a kind of *handle* to re-find information. Automatically mined social networks may be too expansive and unwieldy for such use. Furthermore, research has shown that at any one time, a person's active set of social interactions typically number in the range of 7-12 groups [1]. This "live" [16] network of people is continuously changing on a need-to-need basis and is a much smaller subset of all the people one knows. Hence, making conscious and deliberate configuration of one's social orbits renders them more practicable and effective as handles for information access.

Tagging Information Objects with Social Orbits

We implemented our prototype system on Mac OS X 10.5+, which allows us to use DTrace [6] to monitor information activity, and Spotlight [17] to tag different information objects. DTrace supports the deployment of system probes that inform us of such information activity as files being opened, written, and closed, e-mails being received along with their attachments, and web pages being accessed. These constitute 'meaningful' information activity associated with specific information objects. As discussed below, our system supports dynamic tracking of the physical-social presence of individuals in one's social orbits. If at least one person in a social orbit is present, we deem the social orbit to be present with a 'strength of presence' measured by the proportion of the members of that orbit who are presently co-located. When an information object is accessed, it is tagged with all social orbits that are wholly or partially present.

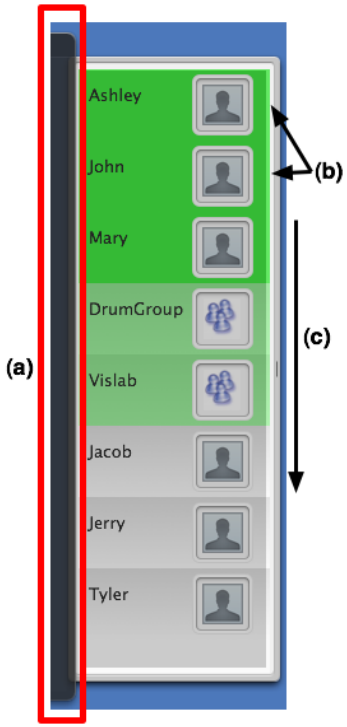

Figure 1: The interface consists of a list view that slides out when moused over; the black bar (a) is all that is seen when the application is not used. Each social orbit has an icon and name (b) and they are ordered by number of people from the social orbit who is present (c).

The application determines which social orbits are present using two methods:

- **Automatic**: A light-weight custom awareness device was seeded to participants and people in their social orbits. Our prototype device employs the low-power XBee radios [21] that can report the presence of other registered similar XBee-based devices. This device automatically informs the user's application of who is present so that information can be tagged accordingly. The system also automatically tags emails and attachments using sender/receiver information.
- **Manual**: The user is able to set people, or whole social orbits, as being co-present through an interface. Manual control overrides the automatic awareness device.

Interacting and Re-finding with Social Orbits

Figure 1 shows the user interface of the social orbits application. It takes the form of a slide-out drawer that activates with a mouse-over action on the black bar on the left of the user's screen. This makes the interface less intrusive. What is seen in this figure is the list of social orbits, first arranged by 'presence' and then alphabetically. This list can be scrolled to show non-present social orbits. Double-clicking a social orbit can either activate or deactivate it as being present, overriding any triggering from the automatic awareness device. Right-clicking a social orbit brings up a Spotlight SmartFolder that lists all information objects that are tagged with that social orbit. These SmartFolders are simply saved search folders; users can interact with them in the same way as with other standard folders, e.g., ordering by modified date.

Case Study

Methods, Procedures and Data Collection

Typical evaluations of information systems, including applications for re-finding, are problematic. Our hypothesis is grounded on the idea that social connections bring meaning to our information objects, and this meaning participates in the process of re-finding. This suggests that a staged, 'one-shot' study is not appropriate to explore how one's sense of social meaning helps in information re-finding. Evaluation of our application requires real use, whereby real social connections are available and meaningful information use is meaningful. Therefore, we chose to take an in vivo approach [3] to evaluate our application. We seeded the application with three professors (lab heads) in our Center. While the "professor/academic environment" may not be fully representative of all real-world use scenarios, our three participants exhibit a wide range of information management behaviors that may allow us to gain greater insight. They run three of the largest laboratories in our Center, and they have to juggle multiple projects and attend many meetings throughout their day. In brief, they are representative of users who have a need to re-find documents many times during the study period, providing the most opportunities to evaluate our application and hypothesis.

Each participant was asked to run our application on their laptops for two months. They were given a tutorial on how to create and use multiple social orbits for tagging and re-finding information. The participant and a number of people in their respective social orbits were given the automatic sensing device. Due to the small number of devices built (10), some social orbits relied only on manual activation by the user. The three case studies were run sequentially, beginning with one participant then

moving to the other two participants a few months later. Our first participant also served as the 'beta-tester' of our system to work out some of the inevitable system bugs. This allowed us to make system adjustments and bug fixes prior to our later two case studies.

The application collected timestamped logs of all tracked social orbits, names of information objects accessed and tagged, and social orbit SmartFolders opened. We also presented the participants with a use-diary to log their experience with the system. The participants provided comments on system-use and the usability of the system. Our first participant volunteered to do an hourly log to give us a fine-grained understanding of the workings of our system, and to report on usability issues. Our other two participants were polled for diary entries on a daily basis. We also conducted pre-interviews to get a sense of the participant's information practices prior to the study, including how they organize and re-find digital information and how they use it in social situations such as meetings. Lastly, exit interviews were conducted to probe deeper into the system's overall adoption, use and effects.

Findings

We begin by describing each participant's prior information management practices, including how they use information during physical-social interactions. We then present the adoption and use experience of the system of each participant gathered from application logs, diaries and exit interviews.

Prior Information Use

The three participants were distinctively different in their information filing strategies, and in their use of information during meetings.

Participant 1 (P1) is a loose filer/spring-cleaner. He employs many folder structures, organized by people, projects, papers, grants, etc. However, he noted that he does have trouble keeping up with his structure, especially when dealing with information that cut across multiple domains – e.g., a paper related to a project given to him by a student could be filed in any of three (papers, projects, and students) folders. He also mentioned that he often leaves information "inside" his email client because it makes them "easier to search for". His meetings often take place in a secondary office equipped with a large 56" display. He prefers to use documents such as outlines, progress reports, data analysis reports, etc. on this display to "drive" the meetings. Prior to the study, he used a computer that was hooked up to the large display in his secondary office for the collaborations. He would synchronize collaboration folders with his laptop that he uses as his primary machine. For the study, he stopped using the collaboration machine, and simply hooked up his laptop that was running the social orbits program for meetings. This was so that the social orbit tags and SmartFolders could be used to support both his personal work and meetings.

Participant 2 (P2) is a strict filer who has clear rules for where different information should go. His folder structures were similar to P1 and his email client contained "two-hundred [folders] at least, with several levels deep in hierarchy". He has "a pretty good mental map of where all those folders are," and is "pretty confident that (he) can get to any topic very quickly." The only information he admitted to not organizing was his downloads folder saying, "I don't feel the need really to organize that stuff for the most part because I know that I can get to it easily with search". During meetings he would seldom use any form of digital information.

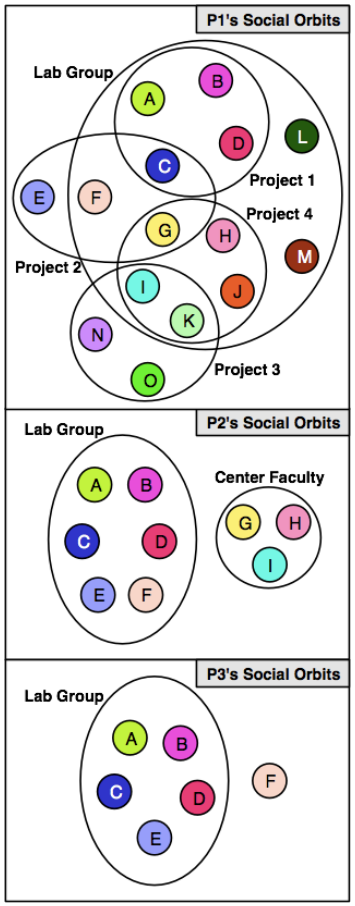

Figure 2: Illustration of the three participants' social orbit configurations.

When this did happen, he used a note-taking application that he goes "straight to". Each note represented a meeting – "I have 79 notes...that represent a lot more meetings because I get a lot of my regular meetings in just one note, where I just keep appending." He said that re-finding these notes was never a problem for him. Other information used at his meetings was displayed on the computer screen of another person – "...they have their laptop, and they open up on their laptop and we looked at it together. So I'm not necessarily doing anything with documents on my laptop".

Participant 3 (P3) has a somewhat unconventional information management behavior, in the sense that he was "not good at being organized". His strategies consisted of piling everything on the desktop until it was full, then dumping all files into a "Desktops" folder. Interestingly, his method of re-finding information was through his students – "So often times...whenever I need a piece of information I don't go looking for it here [points to computer], I go ask one of them for it." His information use during meetings is similar to P2 – "When I meet with people, I tend not to work that way, I tend not to work with stuff on here [points to computer]". Like P2, he also noted that sometimes his students or collaborators would discuss information on their own laptop screens.

P1 used the system for two months with eight student/collaborators carrying the automatic awareness device. P2 and P3 used our system for two months concurrently. P2 and P3 each had four people with devices, but some of these student/collaborators worked with both P2 and P3. We note that the social orbits used by the participants can and did exceed the number of individuals who carried the automatic awareness devices, through the use of the manual 'click on/off' method of marking collaborators' presence.

Adoption and Use Experience

Table 1 summarizes results from the system logs for each participant. The social orbit configurations for each participant can be seen in Figure 2. The number of people and groups each participant added was relatively small and each participant also accessed about the same number of total information objects. We now discuss each participant's experience with the application that we gathered from the diaries and exit interviews.

	P1	P2	P3
Days Used	56	52	50
Social Orbits	15(5)	9(2)	6(1)
Accessed Objects	1945	2148	2360
Tagged Objects	747	36	49
SmartFolders Opened	48	5	2

Table 1: Summary of system logs for each participant. The social orbits row's notation is total number of people with number of groups in parenthesis.

P1: From the logs and exit interviews, P1 clearly found the system more useful than P2 and P3. In his logs, it can be seen that he had more information objects tagged either manually or automatically. He also opened a social orbit SmartFolder about once a day. In his exit interview, he noted that he often left these SmartFolders open and used them much more than once a day. He created most of his social orbits during the first two weeks. As his work changed, he added more or changed older ones. P1 liked how the application allowed him to "decouple" his tasks of information storage and information re-finding. He did not have to remember where he filed a piece of

information, a process he highlighted as bothersome in his pre-interview. With the system, he relied on the context of how he used it and not on a "filing decision" he made days or weeks ago. Another interesting point is that on several occasions, P1 set social orbits to present even while alone. He used this feature to "remind" himself about sharing a webpage or paper with someone the next day when he popped up their SmartFolder.

P2: P2's use of the system was somewhat limited as compared to P1. After a couple of weeks, his system use declined due to conference travels and vacations. During the early parts of the study the participant set up his social orbits and preferred to use the manual method to set them to present. Even though he accessed about the same number of information objects as P1, only a few were actually used in the course of meetings (and were thus not tagged). It was not "too much of a burden having to remember to double-click those people" for him, but due to his practice of not using much digital information during meetings, setting people to present was not very useful. For the few files that were tagged, he did not use the application to re-find them. For example, if it was a note, he would go straight to the note-taking application or if it was an email, he would go straight to the email client, reducing his "motivation to keep double-clicking on people and tagging things." The few times that he used a SmartFolder was more out of curiosity and not for re-finding a piece of information. He found that he rarely had an occasion when his "normal [re-finding] mechanisms" would not work.

P3: P3 used the application for the first week and, after conference travel, did not go back to using it. During the first week of use, he created his social orbits and used both the automatic awareness device and manual method to tag information in a few meetings. After this first week, however, his use of the system stopped. He said he never remembered to use the device or set people to present. He also never used the application to re-find documents. When asked why, he said, "in the heat of the moment when I'm trying to find something, that thought wouldn't occur to me...I'm just not aware of that possibility." The majority of information objects tagged were done automatically through email activity. During the exit interview, we reviewed some social orbit SmartFolders. P3 was surprised "how we knew about this stuff" because the information all made sense in terms of relating to the correct person.

Participant 1 Re-visited

With regard to each participant's prior information practices, all three participants used both people and groups to organize a large portion of their information. It could be argued that a large part of P1 and P2's folder structures can be broken down or re-organized into either a person and/or group (e.g., papers, grants, classes, etc.) P3, while not having any folder structures, relied heavily on students to re-find information. His first instinct was to "go ask one of them" for it. With this type of behavior used by all three participants, our system had some potential to be useful.

However, a significant challenge to our hypothesis, that real-time use of digital information in physical-social interaction provides a means for information organization, arises from the non-use of digital information during meetings by P2 and P3. Without co-temporal physical-social activity and information use, there is just nothing to tag even when social configurations are tracked. This seems counter-intuitive in our increasingly digital world. A corollary question is how digital

information use may become more integrated into our physical-social interactions. A clue to answer this question may be seen in the difference between P1 and P2, both of whom organized their information along the lines of people they work with, and activities (such as projects, paper writing, and proposal preparation).

One critical difference between the physical-social interactions of P1 and P2 is in the way P1 mediates his meeting activity with the use of a large display. We had the serendipitous opportunity to explore this difference, while still running our studies with P2 and P3.

As we described, P1 holds meetings in a secondary office with a large screen display. This display provides a point of shared focus among all present at a meeting. This practice also aligned with our initial assumption that people tend to use digital information during meetings, which explains how our application was more useful to P1. After P1's study period was over and toward the end of P2 and P3's study, P1 happened to lose the use of his large display for a period of about four weeks. This allowed us to explore how this changed his behavior in terms of using digital information in physical-social interactions.

P1's use of digital information dropped suddenly with the loss of his large display. His practices began to resemble that of P2 and P3 during meetings. He showed us the different notes he kept for each meeting and they had not been updated during the period when the large display was absent. The only time some form of digital information was used in a meeting was when the student used their laptop. This behavior, demonstrated by all three participants, led us to consider an important question: how does a shared focus display affect the use of our system and overall information use during physical-social interactions?

We posit that the large display creates a locus of digital interaction for the meeting, in a sense allowing the digital world a foothold in the physical-social configuration. By materializing the information in a 'physical way' the data become social, therefore incentivizing their use. This insight is analogous to the way social media facilitated the explosion of digital photography. An article in the New York Times [13] describes how photographs on Facebook increased while Flickr's use diminished. The former makes photographs social while the latter focuses on the technical aspects of picture tagging and finding. Users being able to tag and thus browse photos by friends (and friends of friends) creates a natural way for people to organize, share and even discover (i.e., navigating to friends of friends' photos). When people could share their pictures, it made more sense to take them in the first place – nostalgia brings to mind the Polaroid camera.

Returning to P2's post interview, we find that he did take notes on his laptop when he led faculty discussions and was responsible for coordinating activities, but not when "[he] is just a spectator at the meeting" or when '[he is] not in charge". Digital notes became useful when he had the responsibility to share them with other meeting members. In other words, it appears that P2 uses digital information when it serves some *social purpose*. This extends Erickson and Kellogg's assertion that we need new software tools to support social processes [9], by adding the need to support use of digital information in real-time physical-social interactions. Our observations raise the possibility that technologies that afford information use in a physical and social way are still absent from widespread use. This provides tremendous opportunity for further research and innovation.

Returning to our initial hypothesis, information use in physical-social interaction may well support re-finding and reuse. This may, however, be predicated upon the introduction of real-time tools for physical collaboration. We hope to continue this direction of research uncovered by our case studies.

Conclusions and Future Studies

Previous research in socially-based information re-finding have concentrated on the social interactions that occur in the cloud, i.e., email. We are interested in employing the context of physical-social interactions as a way to index a person's information. Our prototype application enables users to tag and re-find their information objects based on people and groups they physically interact with. We presented our findings from the two-month long studies of three participants using our application. All three participants had different ways of managing their information and yet all demonstrated some form of information access using people. However, the amount of digital information used during physical-social interactions affected the overall impact of our application. We want to explore this notion of using a large display as the focus point for interacting and sharing digital information. Much of the digital information we create and organize is meant to be shared and we may not have technologies that properly support this type of real-time information use and organization.

In the future, we want to re-visit the use of our system with the above idea in mind. Our future studies include running additional in vivo studies of people using our system in a context that includes such technology affordances as shared large displays.

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