Building Social Discourse Around Mobile Photos – A Systemic Perspective

Risto Sarvas, Antti Oulasvirta, Giulio Jacucci

Helsinki Institute for Information Technology HIIT
P.O.Box 9800, 02015 TKK, Finland

{risto.sarvas, antti.oulasvirta, giulio.jacucci}@hiit.fi

ABSTRACT

Camera phones have been viewed simplistically as digital cameras with poor picture quality while neglecting the utility of the two key functionalities of mobile phones: network connection and access to personal information. This is the first HCI paper to examine mobile photos from a *systemic perspective*: how assignment of phases of mobile photo lifecycle to different platforms affects social discourse around shared photos. We conducted a 6-week user trial of MobShare, a tripartite system with dedicated functions and task couplings for a mobile phone, a server, and a PC browser. We analyze how MobShare's couplings and distribution of functionalities affected the observed types of social discourse that formed around mobile photos: in-group post-event discourse, self-documents and reports, greetings and thanks. Several central design issues arising from the systemic view are discussed: heterogeneity of environments, integration and distribution of functionalities, couplings and decouplings of interaction tasks, notification mechanisms, and provision of necessary UI resources for different tasks.

Categories and Subject Descriptors

H.5.1 [**Information interfaces and presentation** (*e.g.*, HCI)]: Multimedia; H.4.3 [**Information systems applications**]: Communications Applications.

General Terms

Design, Human Factors.

Keywords

Camera phones, systemic perspective, user study, user interface design, digital image management, heterogeneity.

1. INTRODUCTION

Mobile phones with integrated cameras have penetrated the market and are the most sold digital cameras worldwide, and the marketing pitch is that as technology advances the 2-4 megapixel camera phones will replace digital cameras in everyday life. However, mobile phone cameras are still a novelty that has not, from the users' perspective, become an everyday device with common uses and functions. Although mobile phone cameras have technical advantages in contrast to regular digital cameras, such as an inherent network connection and access to personal and contextual information, mobile phone cameras are conceptualized as *cameras*, and therefore, are compared to digital cameras which often have better picture quality, a clear functionality, and use inherited from pocket film cameras.

MobileHCI'05, September 19–22, 2005, Salzburg, Austria.

Our starting point is that mobile phones have been seen too simplistically as devices for only capturing images for personal purposes, whereas their potential in inspiring social discourse has not been carefully researched. We are interested in exploring how the design of a picture sharing system provides resources and imposes restrictions for constructing discourse around mobile images. We examine mobile photos from a *systemic perspective*: how assignment and coupling of phases of mobile photo lifecycle to different types of platforms and terminals affects social discourse around shared photos. We conducted a six-week user trial of MobShare [18], a tripartite system with dedicated functions and task couplings for a mobile phone (capturing, transferring, sharing), a server (archival, distribution), and a PC (viewing, discussing). We analyze how MobShare's couplings and distribution of functionalities affected the observed types of social discourse that emerged around mobile photos. We conclude the paper by discussing design issues arising from the systemic view, especially the heterogeneity inherent in MobShare and similar photo sharing systems.

1.1 Related Work

Research on sharing digital photographs includes studies and systems from different angles: studies of multimedia messaging, mobile applications on smart phones and Pocket PCs, tangible applications, web-based systems, and metadata. Most of the studies focus on personal applications while only few on professional applications or workplace settings.

Some field studies have shed light on practices in multimedia messaging using camera phones. The study by Koskinen et al. [12] pointed out that content in MMS messages between friends is rarely independent from previous communication. People also started to create collections of pictures on the same topic, such as variations of a joke that had been circulated within the group. Battarbee's study echoes these findings [3]. In both studies, communication of moods was one of the main use purposes as well.

Previous field studies have studied photo-sharing behavior of families and children with a particular emphasis on storytelling. Mäkelä et al. [13] show how mobile devices can also be used for recording digital media that is assembled into a coherent story at a later stage. They found that pictures were taken not only about special situations, but often to create stories, illustrate everyday life in a funny way or to make art. Frohlich et al. have studied the

requirements for groupware for sharing photographs [10]. They propose a requirements framework based on whether the people sharing the photographs are in the same place or time. They identify four categories for sharing: co-present sharing, remote sharing, sending, and archiving.

Kindberg et al. have studied what people photograph with mobile phones and how they use them [11]. They identified six categories of camera phone use based on the intentions behind the captures. Affective intentions included enriching a mutual experience, communication with absent friends or family, and personal reflection or reminiscing. Functional and more utilitarian intentions were support for a mutual, remote or a personal task.

In [7] a system is proposed that supports "group-centric sharing, automatic and persistent people-centric organization, and tightly integrated desktop and mobile sharing and viewing." The interface is simple and supports "buddy-lists" based groups, but its shortcoming is the impossibility to share pictures with groups that are not predefined, and that the pictures are organized merely according to the person that shared them making it difficult to organize pictures according to events. In [16] a system is described that combines photo annotation tasks with instant messaging. Sharing and annotating digital photos can happen online over the Internet while people are chatting online. In addition to manual annotation, the systems can extract information from conversations to generate extra annotations. "The Personal Digital Historian" in [20] allows users explore digital archives of shared materials such as photographs, video, and text documents on a tabletop interface. Balanović et al.'s [2] tangible digital photo album tries to replicate the functionalities of traditional paper photo albums. With their device, users are manipulating digital images and can also share them.

In the following section we show that mobile picture systems are actually distributed architectures rather than single terminals. None of the research above, or that we know of, has studied how functionalities and interfaces are distributed over a heterogeneous architecture.

2. SYSTEMIC VIEW TO MOBILE PHOTO LIFECYCLE

From a systemic point of view, the analysis of mobile photo lifecycles must include all the involved terminals and devices, not only focusing on individual devices and interfaces. Photographs are mainly viewed and shared with other people [1][10]. Especially in domestic photography, pictures are often taken to be shared with friends and family. This social characteristic of photographs implies that the lifecycle of a photograph is distributed over several devices.

To share photos taken with a mobile phone camera they can be shown from the screen or transferred to another device for viewing. There are currently four popular architectures for transferring photos from the phone: (1) to another phone over the network (*e.g.*, MMS), (2) to a PC (*i.e.*, the same procedure as with regular digital cameras), (3) to a network server over the network, and (4) to a printer over a cable or Bluetooth. Each of these ways of transferring pictures has unique characteristics. For example, transferring from phone to another phone enables immediate sharing of pictures to practically anywhere the recipient happens to be with her phone. On the other hand, transferring pictures to one's own PC is often a familiar way of managing digital photos: once the photos are on the PC they can be edited, organized, published, *etc*. with the vast variety of applications. Also, there are no transfer costs between a phone and a PC or a printer, unlike often is the case in over-the-network transfers (*e.g.*, MMS or GPRS costs).

We divide the lifecycle of a mobile picture into five subsequent phases. These phases are intuitive for any photographer and, at the same time, emphasize the *heterogeneity* of mobile picture sharing architectures.

1. *Capture* of picture using the mobile phone.
2. *Transfer* of pictures from the mobile phone.
3. *Sharing* of pictures means making pictures available for other people to view and discuss, and as a recipient, being notified of pictures available for viewing and discussing.
4. *Viewing* the pictures involves not only looking, but also the related social interaction, such as talking about the pictures and commenting them.
5. *Archival* of pictures for later use, for example, a shoebox for paper photos, or a CD-ROM for digital pictures.

In Table 1 we have compared most common mobile picture sharing architectures in relation to the lifecycle described above. We also included the lifecycle of a traditional film camera photos as a contrasting example. The table makes the following points:

- Lifecycle is technologically *distributed* over several devices.
- *Coupling* of lifecycle phases can be integrated in the system (*e.g.*, transfer and sharing in MMS are coupled into one function).
- None of the architectures are designed to have *continuity* over the whole lifecycle.
- Some *transitions* between lifecycle phases require user effort (*e.g.*, transferring pictures from phone to a PC).

Table 1. Lifecycles in common photo sharing architectures.

Architecture	Capture	Transfer	Sharing	Viewing	Archival
MMS	Phone camera	Over the network when shared	Coupled with transfer. Shared individually	From phone screen	Phone's message in-box. No archival support
Phone to PC (same as digital cameras)	Phone camera	Cable, memory card, or Bluetooth	Variety of sharing methods	From PC screen, via web browser, printed photos	PC's hard disk, web server, CD-ROM
Photo Blogging	Phone camera	Over the network when shared	Coupled with transfer. Shared on a web page	Via web browser.	Web page. Often no explicit archival support
Phone to Printer	Phone camera	Cable, memory card, or Bluetooth	Shared by showing printed photos	Tangible viewing of paper photos	Photo album, "shoe box", framed
Traditional Film Camera	Film camera	Film roll development	Shared by paper photos	Tangible viewing of paper photos	Photo album, "shoe box", framed

2.1 Picture Lifecycle in MobShare

In this paper we focus on the third way of transferring pictures: from the phone to a network server. MobShare system is based on this kind of a client-server architecture, where the pictures are accessed by others on a web server. The apparent characteristics of this architecture are the coupling of transfer and sharing into one task, having own and friends' pictures in one place (not on everyone's own PC), and more people have access to a web page

Figure 1. The sharing of pictures in the MobShare phone client. First the pictures are selected for posting, and then a new gallery/album is created for the selected pictures. The gallery is named and the recipients are selected. In the end the pictures are optimized and uploaded to the web server.

than a phone capable of receiving images. This architecture is popular in photo blogging, where people share pictures directly from the phone to a web page.

The MobShare system consists of two main parts: the client component that relies on the user's Nokia Series 60 smartphone, and the server component, which runs the web page interface. The client component has the functionality for transferring and sharing pictures and the server component (*i.e.*, the web pages) have the functionality for viewing and discussing the pictures, as well as, editing, creating, and sharing galleries.

Capturing pictures is not implemented in MobShare. The user takes the pictures with the phone's built-in camera program and uses the MobShare client only to transfer and share the pictures. The *transfer* and *sharing* of pictures is coupled in MobShare. The interaction steps for sharing pictures are presented in Figure 1.

MobShare does not publish the images but limits access to galleries on an individual basis. For each gallery, the user has to explicitly choose the people who have access to the gallery, or in other words, who the gallery is shared with. There are no pre-defined lists of users (*i.e.*, buddy lists) that the user can take advantage of.

Once a new gallery is created the people who the gallery is shared with get an SMS *notification* to their phone. The notification invites the recipient to visit the new gallery in the given URL, and it includes the name of the person who shared the pictures and the name of the gallery.

To *view* the pictures, the user logs into the MobShare website with her phone number and password. There she will have her personal view of all of her own galleries and the galleries shared with her (see Figure 2). The galleries are organized in temporal order and according to ownership. The width of the gallery in the visualization is the time between the capture of the first and the last picture in the gallery. By selecting a gallery the system shows all the thumbnails of all the pictures in that gallery. By selecting a thumbnail the picture is shown in full size, and a textbox for comments. The pictures can be commented individually, and a summary of the comments for each picture is shown next to the thumbnails. There is also the possibility to comment the whole gallery rather than an individual picture. Galleries can also be created in the web browser interface of MobShare, where the functionalities are much more versatile (*e.g.*, adding and removing recipients of a gallery, creating galleries with no recipients, and deleting galleries). On top of the thumbnails there is a list of the people who the gallery is shared with. If the gallery is the user's own, there is also a list of all the people who have visited the gallery. Any pictures or comments that have been shared since the user's last visit are colored red.

Unlike public blogs or web pages MobShare is built for controlled sharing, meaning that the user has full control over who have access to the pictures. This also means that for each gallery there is a distinguishable group of individuals associated with it. Also, by having one's own and other people's pictures in one location, it is possible to organize them in a single view inside a web page.

3. METHOD

The study consisted of a group of five users (core users), and 48 additional users who the core users shared pictures with (secondary users). Each core user was given a camera phone to use as their primary phone for 5-6 weeks. The users were given a short introduction to MobShare and the basic functionality of the phones. It was emphasized that using the system was by no means compulsory. All of the data transfer costs for uploading the pictures were paid for, and all of the core users were paid a fee for volunteering in the study. Three interviews were arranged: before, in the middle, and after the trial period. The interviews were mainly about the use of MobShare but also on photography habits and social networks. In addition, the users were asked to fill out a diary, and the MobShare server logged the users' activity. We also had access to all the pictures taken with the camera phone.

The core test group was a group of friends who had known each other for several years. They were aged 25-26, four female and

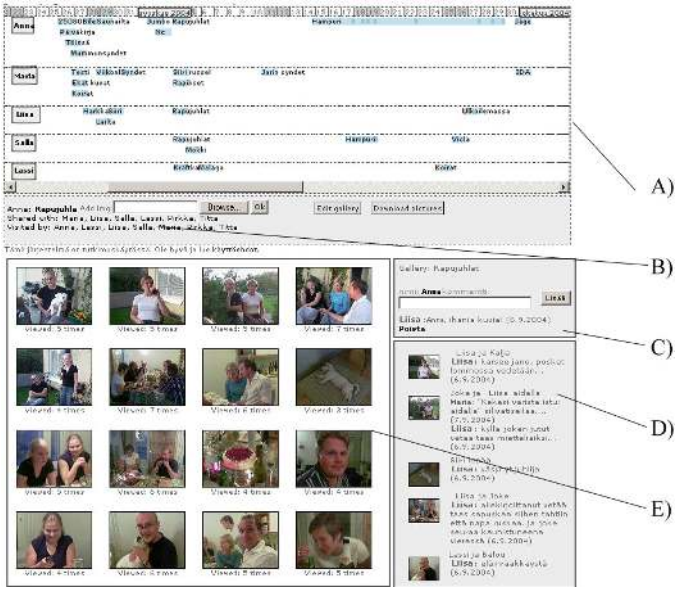

Figure 2. The web page interface of MobShare. A) User's own galleries, and galleries shared with her. B) List of people who the gallery is shared with and who have visited it. C) Gallery-level comments. D) Picture-level comments. E) The thumbnails of pictures in the gallery.

one male, two of whom were a couple, living in the Helsinki metropolitan area. Four of them had an academic degree and all were employed. Two of them also studied during the trial. All of them were familiar with emailing, web browsing, and SMS. None of them had owned a camera phone or a smart phone before. Two of the users shared one digital camera, and the rest had film cameras.

The study included the 48 secondary users who were invited by the core users to view the shared pictures. No fees or costs were paid to these secondary users, and they were not interviewed nor were they keeping a test diary. Their activity was logged by the MobShare server.

4. RESULTS

4.1 Capturing, sharing, and sending pictures

During the test period the five core users took 589 pictures and shared 525 (89 %) of them at least once. The pictures had most often (70 %) a person or group of people as central figures. Twenty-one percent of the pictures had an object in the picture, 13 % had a location or scenery, and 12 % had a dog in an important role. The categorization was not exclusive, in other words, one picture could have a person, a dog, and scenery as important parts.

Majority (90.3 %) of the pictures were taken either in the evening (after 17:00) or during weekends. When asked about why there were so few pictures during working hours, one test person answered that nothing significant happens at work. Majority (84 %) of the pictures shared were taken within three days prior to sharing (see Figure 3). The actual sharing happened mostly in the evenings (60 % 17:00-01:00), and the most popular times were Friday (19 %) and Sunday (14 %) evenings (17:00-01:00). These numbers indicate that the sharing was not immediate in the way that once a picture was taken it was shared (the average time difference between capturing and sharing was 64 hours).

4.1.1 Dynamic Creation of Groups

The groups that were created for each gallery were dynamic and situated. Dynamic in the sense that although there were some regularities (*i.e.*, certain persons were often in the group) the regularity was not strict. For example, the core users were often together in the list of recipients, but their friends outside this core group were not included regularly, but depending on the pictures shared and the situation where the sharing happened. Figure 4 and Table 2 illustrate how the user-created groups were dynamic and undefined rather than clearly circumscribed. Even when a gallery was shared exactly to the same people as previously (*i.e.*, re-occurred), they were mostly individuals rather than groups.

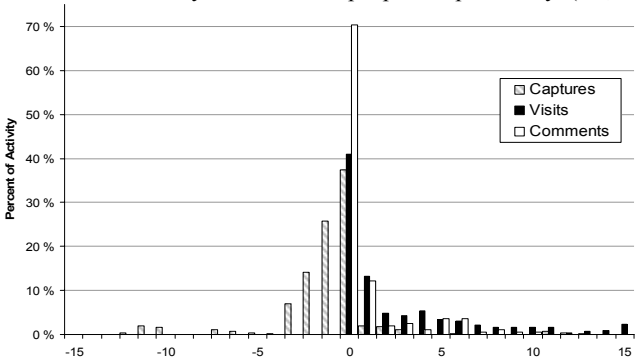

Figure 3. Average lifecycle of a MobShare gallery, difference in days between sharing and captures/visits/comments.

Sixty-four percent of the recipients the galleries were shared with were friends, 24 % were relatives (including spouses and their relatives), and 12 % colleagues. This reflects also the technical feature that the user has to have added the recipient's phone number in her phone book to be able to share the pictures. The numbers in Table 2 and the visualization in Figure 4 illustrate the dynamism and situatedness in deciding the recipients. Group-forming was related to the content of the pictures: who were present at the event where the pictures were taken; who usually would have been present; or who shares an interest in the pictures taken (*e.g.*, dog owners and pictures of dogs, or relatives and pictures of family events or travels). The recipient's technical skills and access to the Internet also influenced sharing (*e.g.*, a user did not share to a person because she thought that the recipient would not know how to use the system). The recipients who did not visit the galleries at all, or who were thought to be puzzled or bothered by the SMS notification were not shared with.

Table 2. Individuals vs. groups of recipients assigned by users to shared galleries.

user	galleries	total recipients	different groups	re-occurring groups
1	10	20	10	0
2	20	14	17	3 (three different groups)
3	12	9	10	2 (friend, group of friends)
4	12	9	9	1 (spouse)
5	20	24	18	2 (spouse, sister)

4.1.2 The Contents of the Galleries

The core users created 74 galleries during the trial period. This sub-section presents a classification based on the circumstances in the world the gallery refers to, according to the time periods and locations referred to. Based on the content of the gallery, five major categories were distinguished: *Event*, *Theme*, *Travel*, *Exploring the System*, and *Other*. This categorization is based on the event-based approach familiar in personal media management applications and multimedia literature (see, *e.g.*, [6]), where events have an important role in organizing pictures.

Events (53 %)**.** These galleries included parties, birthdays, meeting or visiting friends or relatives, and happenings at the office. The pictures in these were taken mostly during one evening or

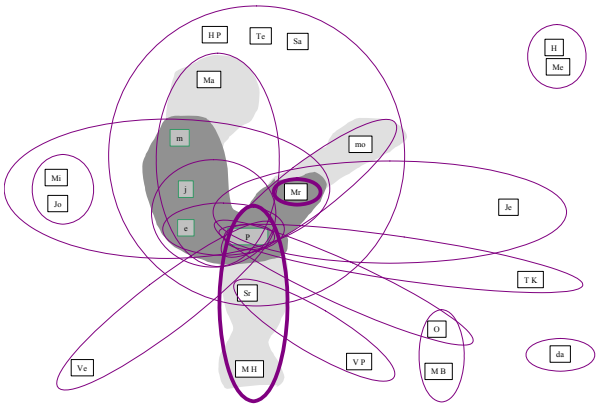

Figure 4. One user's sharing of galleries to individuals. A circle denotes the persons one gallery was shared with, a thicker circle meaning several instances of sharing. Core users' rectangles are colored gray. The background color connects who were often together in the list of recipients, a darker color meaning stronger connection.

one weekend. The names given to galleries depended on the type of event, and the shared knowledge of events, people, and places among the sender and the recipients. For example, a gallery of birthday pictures was named "Birthday", and that was a sufficient description to the recipients who knew that the gallery owner's spouse had had a birthday. A gallery of party pictures coming from a colleague meant the office party the previous weekend, and therefore "Party Night" was a sufficient gallery name. A gallery of pictures of sister's visit to the sender's home was named "Last Sunday", and for the single recipient, the sister, it was obvious what the gallery was about. The name of a city, a shopping mall, a person, and a conference were used in a similar manner.

Themes (16 %)**.** The most popular theme among the group was dogs (8 out of 12 galleries categorized as Themes were about dogs), especially the new pet dog that was bought during the test period. The other themes were baking ("Pastries", "Delicious pastry"), sitting in a bar ("Oh boys"), at work ("At work"), and pictures of a colleague before and after a haircut (the name of the gallery was the name of the colleague). However, we recognize that the distinction between Themes and Events is ambiguous, and some of the galleries could have been categorized as Events. For example, the two galleries about baking of pastries were both a single event considered special by the photographers, and the sitting in a bar was two separate events bundled into one gallery. Also, 10 of the 12 theme galleries were taken during a single day.

Travels (11 %). Galleries categorized as Travels were trips abroad that therefore had a distinctive beginning and end. This category was also very similar to Events, and travels are often considered as a certain kind of event. The pictures in the Travels galleries spanned from the beginning to the end of the trip. All of the names of the Travels galleries were the names of the travel destinations (*e.g.*, "Hamburg", "Malaga", and "Ibiza").

Exploring the system (9 %). These were galleries that were made first to get acquainted with the system: how it works, and what the pictures look like in the web pages. This signifies that there was a learning curve to the system.

Other (11 %). In addition to the previous category, this category was clearly not an event. Two of the eight galleries in this category were a collection of pictures from several events (see Section 4.3.1 on "Greetings"). The other galleries in this category were individual pictures shared with one person, for example, to show what the sender's new boyfriend looked like, and a picture taken candidly of the recipient before she woke up; two pictures of the recipient taken at different times, which was sent as a kind of a gift; a joke about how the recipient of the gallery was holding the sender's new dog like it was her own; a combination of the recipient's visit to the sender's home and a boat trip discussed during the visit; and a call for help in choosing what to wear to a wedding (see Section 4.3.1 on "Help me!").

4.2 Notification and Awareness

The dominant type of social activity taking place around the MobShare galleries was essentially turn-taking based discourse. Awareness can be characterized as "an understanding of the activities of others which provides a context of your own activity" [9], p.107]. Awareness was upheld via the notification mechanisms mentioned above, and they effectively imposed both constraints and provided resources for group members to carry out the discourse.

The framework for discourse had to be *initiated* by notifying via SMS the recipients that a created gallery has been disclosed to them. We observed how, due the course of the study, users learned to appreciate the SMS more as an invitation than as a notification. This notification functioned as an implicit request for others to contribute, and thus the users learned to pay attention to the content of the message, many trying to make it informative yet inviting to engage others. For example, "Help me!" in choosing an appropriate dress for a wedding.

The MobShare client version used in the study included no functionality to write captions or comments before sharing, which caused few occasions where the users withheld sharing of a gallery until they had Internet access and could write descriptions to the gallery. One user commented on postponing the sharing: "I wasn't sure that [the recipients] would understand what the pictures were about." She also told that she tried to make the gallery names communicated by the SMS as informative as possible of the gallery's contents. Some users quickly learned that the name of the gallery was not only a label for a set of pictures, but an invitation to contribute to the gallery. In the case of the "Help me!" gallery, the sender even phoned the recipient to ensure her rapid response. Nevertheless, despite the gallery owners' efforts to ensure timely responses from the recipients, the interval between the latest SMS notification and actual visit by the recipient was actually as long as 43 hours on average (94 % of data; outliers removed, *e.g.*, visits after test period).

In the following discourse around a gallery – a turn-taking process of visits, comments, and replies – users had to rely on the MobShare web interface as a source of information on the status of the discourse. We observed that turn-taking behavior in MobShare relied on expectancies generated by the semantic content of the preceding turn. For example, greetings created an expectation for responses, and questions for answers. After the initiation of the discussion, especially owners, but also active discussants, made routine checkups to follow if others had taken turns. The numerical data of the five core users shows that 73 % of their sessions with the web interface were not preceded by a notification, 60 % of visits were to their own galleries, and 45 % of their sessions lasted about one minute – observations that well reflect the core users' tendency to do rapid checkups to follow the discussions they had initiated or engaged in, especially in their own galleries.

Awareness on the progress of the discourse is afforded in MobShare by red coloring of new comments and pictures in the timeline view and by information on who has visited a gallery and who has not (see Figure 2). Typically, discourse lasted for six days (95 % of comments were written during six days after sharing, see Figure 3), after which there was an implicit consensus to stop discussing on the pictures, although they were visited at times to remind oneself, typically the owner, of the discussion and the pictures (98 % of visits to galleries were during ten days after sharing, see Figure 3). Here, if a user joined late to the gallery, she could learn from the timestamps of comments that the discussion had peaked earlier. In such a situation, the user rarely commented anything or visited the gallery later, whereas early users who got to participate in the discussion took a much more active role. Thus, the latency between the notification and visiting the gallery is a central factor affecting how active users will be.

In the middle of the user study we gave the core users a prototype application to use on their phones. The application was a phone screen saver that once in an hour downloaded the latest pictures and comments from the user's MobShare account. Unfortunately, the prototype did not function properly and had to be restarted after an hour, but it showed the five latest pictures in the screen saver for an hour. Although the users were not asked to use the screen saver any longer, they occasionally used it to check if they had any new comments in MobShare. In other words, the users' need to know about social activity in MobShare was so strong that they restarted the screen saver to get that information.

4.3 Viewing and Discussing

The users created 74 galleries that were shared with 53 people, including the sender/sharer. Those galleries were clicked open 918 times (8 times per gallery on average), and comments were written to the gallery 196 times (2.6 comments per gallery on average, 36 % of galleries had no comments at all). For the five core users the visits to galleries happened during working hours (84 % on weekdays before 17:00). This is partly due to the fact that three of the users had no Internet access at home and accessed the MobShare web interface only from their office. The average lifetime of a gallery was about one week (see Figure 3).

4.3.1 Discourse Around Galleries

Here we turn to look at users' practical ends for picture sharing. What did users want to, socially, achieve through sharing picture galleries through MobShare? Even though MobShare is a novel system enabling new types of interactions, it was used to achieve purposes that are recognizable from everyday social behaviors. In ethnomethodological terms, people transferred their ethnomethods (*e.g.*, greetings, postcards) to MobShare, and in doing so actually showed remarkable understanding of the system's capabilities.

Storytelling through narrative-like accounts. Narratives are accounts of events that occur over time, presentation of which follow conventions on how sequential events should be unveiled to the audience [4]. Our MobShare user trial showed a range of narrative genres: stories (goddaughter's birthday party narrated to friends), boast ("I wonder who took such a great photo?", as commented by the photographer herself), gossip (picture of a boat belonging to celebrities), eulogy (praising the hostess or the guests of a party), and joking (a joke about how the recipient of the gallery was holding the sender's new dog like it was her own). In our study, storytellers (the owners of the galleries) were naturally the ones usually giving the first accounts, pieces of background information, and interpretations of their own galleries. They were also most eager to follow the discussion around their own galleries. As well known in the narrative psychology (*e.g.*, [4][14]), narratives mediate our subjective involvement in the world and thus shape both how we attend and feel about events. Therefore, we saw many examples of *closure* of events by comments in MobShare. For example, the hostess of a party wrote a number of comments on the pictures of the party emphasizing the fun they had, how nice the guests were, the quality and amount of food and wine, and her role as the hostess. These comments were subtle, and written in a humorous manner not to be too explicit.

Reports and Self-Documenting. This category, close to storytelling but lacking the story aspect, consists of galleries reporting or documenting some persistent event or life period. For example, one user visiting Hamburg for a longer period of time kept regularly sharing and commenting pictures to her relatives, colleagues, and friends through a gallery named "Hamburg". Another example was a gallery reporting the arrival of a new dog in the family.

Greetings and Thanks. Greetings were often a collection of postcard-like reports of extraordinary events (like of vacations or of events) with only implicit invitation to comment. They were often expressed in the form of what we call *mini-albums*; like paper photo albums, they were careful selections of pictures from various events. For example, one user selected several pictures from separate events into one gallery, and named it "Greetings". This gallery was then sent to her old friend who she had met after a long time. The pictures in this mini-album included the sender's spouse, common friends, and her friends' new dog. The pictures had comments explaining who are in the pictures, and were especially written for the single recipient of the gallery. Examples of thanks were galleries of pictures from get-togethers where the guests thanked the hostesses, and vice versa.

Questions and Opinion Formations. Questions and opinion formations are the most "interactional" by nature, in the sense that they contain an invitation to respond or reply. Functionalities of MobShare seem to support this kind of turn-taking well: galleries can contain several pictures selected from the pool of personal pictures, and lots of room and good resources are provided for giving comments. An example of opinion formation was a picture of a book that was captured and commented to remember what book should be bought.

5. DISCUSSION: HETEROGENEITY

"Design awards … should be given not for discrete, decontextualized artifacts, but for the collective achievement of new, more productive interactions among devices, and more powerful integrations across devices and between devices and the settings of their use." Suchman, [21].

Lately *heterogeneity* has been considered as an aspect of emerging ubiquitous and mobile computing environments. Russell et al. [17] raise the support for heterogeneity as a requirement for ubiquitous environment where interfaces have to work on displays of different sizes using different input-output modalities. This view might trivialize the concept of heterogeneity that has been used also to address the diversity of media and technologies in which people have interwoven current communication patterns [5]. Heterogeneity forces us to consider technological artifacts and tasks not in isolation but as part of an intricate socio-material ecology. Beyond the diversity of input and output interfaces, heterogeneity can describe greater and more detailed aspects of current ICT systems – including the distribution of functionality and tasks in the variety of available channels, platforms, applications, and media. The study on MobShare allows us to define two qualities of interaction design in current heterogeneous environments: artful integration, and flexible and continuous lifecycle support.

5.1 Artful integration

Interaction design must include not only the design of innovative technologies, but rather their artful integration with the rest of the social and material world [21]. Therefore, Suchman suggests new types of design awards: to designs that artfully combine new and existing technologies and practices (valuing heterogeneity and hybrid systems) [21]. MobShare was successful in proposing an integration of existing technologies with novel features and prac-

tices. While other systems, as [7], propose an additional device (a PocketPC), MobShare makes use of already available platforms (camera phone, web server, internet browser) with the advantage of better integrating them with existing information (*e.g.*, the address book of the phone). Assignment of later phases of the lifecycle to a PC browser was learned to be important from the perspective of providing adequate temporal and UI resources for viewing and discussion, but also to enable more users as viewers and contributors. The responsibility of the system, however, does not end in sharing the images, but continues in the form of initiating and maintaining awareness of the discourse among discussants. We reported many user behaviors related to keeping up with the turn-taking based social interaction in the system and suggested improvements to the system in how to support awareness through better distribution of notifications to other terminals (*e.g.,* a PC). Use of web browsers instead of mobile browsers for accessing and discussing the pictures was successful in the sense that many people not owning a browser-enabled mobile phone could be involved. Moreover, use of PCs is typically more resourceful, both cognitively and temporally, in the sense that we have less other tasks to manage and more control over time on our disposal than when we are mobile [15]. This means more resources for contributing to the discussions in MobShare.

From our data it becomes obvious that the distribution of functionalities over platforms is definitely one factor affecting the social interactional nature of the system that emerges through use. The question is not only how to recognize but how to even harness the best qualities of each terminal to encourage meaningful computer-mediated interactions. The contrast between mobile phones and PCs is perhaps best visible in our data on when pictures were taken and when galleries were visited on the MobShare PC client: while 90 % of pictures were captured during evenings or weekends, 84 % of visits to MobShare were made during weekdays before 17:00 (working hours).

5.2 Flexible and continuous lifecycle support

An artful integration has to deal with diversity of tasks that need to be supported with corresponding functions and features. These translate into the alternative strategies of designing for *multiplicity* (involving a collection of specialized parts) or for *openness* (a single component that can be used in various ways) [8]. A heterogeneous environment adds to the complexity of having to distribute the support for different tasks across applications on different platforms. This brings about the issue of coupling and decoupling: what tasks, or phases of a lifecycle, should be coupled to enable continuity and what should be decoupled for flexibility?

Our study on MobShare makes it possible to evaluate specific coupling strategies for the mobile photo lifecycle with a system that was successfully adopted for sharing photos (89 % of users' mobile photos were shared via MobShare). According to the analysis, there were preferred times for sharing (see 4.1) and the sharing was not immediate to the capture (Figure 3). This argues for decoupling capture and sharing as users could better choose when to do the sharing. This decoupling also facilitated the documentation of events with several photos (86 % of galleries had more than one picture and 53 % were of events) and enabled re-use of pictures in other galleries (12 % of the shared pictures were re-used). On the other hand some users delayed the sharing to be able to write captions and descriptions, and this shows a shortcoming in the openness of the phone client in being able to accommodate different uses. Importantly, MobShare's design does not couple picture taking with sharing, so the act of sharing that takes some time and thought can be done whenever there are enough resources for doing that, typically during weekends in our data. Assigning sharing solely to a PC browser would significantly reduce the number of occasions people could do sharing.

Mobile phones are very limited both in accessibility (to others than the owner) and in the interface resources they offer for actually viewing pictures and commenting them. Therefore, it is natural that the actual content resides on a web server, where they can be accessed from any web browser, and their storage and access is not limited to a spatial location. Encouraging access to galleries, viewing, and commenting from PC terminals of course benefits from their much better input/output interface capabilities. The coupling of transfer and sharing in MobShare meant that the users transferred the galleries from the phone as initiations for social discourse and took advantage of the automatic notification messages in inviting and communicating to the recipients. The possibility to invite any contact from every time anew is an aspect of openness as it allows users to accommodate different uses of the galleries.

However, according to our study, more explicit multiplicity would be required in MobShare to achieve better continuous lifecycle support as the two following cases demonstrate. In the case of the "Help me!" gallery (see 4.3.1) the user, in addition to the automatic SMS notification, phoned the recipient of the gallery to make sure that she would comment the pictures next time she would have Internet access on a PC. The fact that the user had to use channels outside the system is a signal that openness is needed in the notification to accommodate different scenarios. Another example that connects to how awareness should be supported heterogeneously is the case of the screen saver test (see 4.2) which would have added multiplicity to the system (a specialized component) and a better continuous support of the lifecycle especially in the viewing and commenting phases.

The analysis of heterogeneity and artful integration through coupling strategies, which we have done with MobShare, can be extended to other mobile picture sharing approaches. For example, the coupling of capture and transfer in the MMM system [19] discouraged picture-taking due to the interruption the transfer task created to the picture-taking flow, especially because of the unpredictability of the transfer network. The decoupling of transfer and sharing in digital cameras adds a task for the user in the picture lifecycle, but on the other hand, enhances the flexibility in sharing, viewing, and archiving (*e.g.,* the vast variety of tools for PCs). Showing photos from the camera, PC screen, or as paper photos is a case of coupling sharing and viewing, which supports an immediate social discourse over the photos rather than the turn-taking several day discourse in MobShare. MobShare coupled viewing and archival in organizing the galleries and the discourse in a gallery-based timeline for later use, thus releasing the users from the cognitive load related to managing storage and archival. However, the archival aspect could not be researched in the user study due to the relatively short time period.

A functionality that could increase the flexible lifecycle support is gallery access on mobile phones. Other awareness features about the social discourse could improve the continuous support of the lifecycle: we have learned that MobShare's gallery timeline view (Figure 2) provides only poor awareness on changes in the galler-

Figure 5. Left: program for transferring pictures from PC to MobShare. Right: an active mobile phone wallpaper for notifying and showing the latest pictures.

ies, which have led us to think about an awareness application running on PC that shows thumbnails of the latest pictures shared to the owner. Figure 5 shows existing efforts to address this issue.

6. CONCLUSIONS

In this paper we have examined the mobile photo lifecycle from a *systemic perspective* and taken that perspective in our user study on MobShare. The study shows how the assignment of phases of the lifecycle to different platforms affects the social discourse and activity around the photos. This has opened a novel way to identify the interaction design qualities of heterogeneous systems as mobile photo architectures are: the *artful integration* of distributed functionalities assigned to different platforms, and *flexible and continuous lifecycle support* in the integration. We argue that coupling/decoupling strategies have a key role in implementing these qualities in inherently heterogeneous systems such as MobShare. To harness the best capabilities of mobile devices, and get over their known limitations, we need to study them as parts in an ecology of devices. We are sure that this approach opens many illuminating perspectives to domains other than photo sharing.

7. ACKNOWLEDGEMENTS

The authors would like thank Esko Kurvinen, Antti Salovaara, Sauli Tiitta, and Marko Turpeinen for their contribution. We also acknowledge the help from Futurice, especially Mikko Viikari.

8. REFERENCES

[1] Akeret, R.U. Photolanguage: How Photos Reveal the Fascinating Stories of Our Lives and Relationships. W. W. Norton & Company, Inc. New York, NY 2000.

[2] Balanović M, Chu LL, Wolff GJ. Storytelling with digital photographs. In *Proc. of the SIGCHI conference on human factors in computing systems (CHI'00)*. ACM Press, New York, NY, 2000, 564-571.

[3] Battarbee, K. Defining co-experience. In *Proc. of the 2003 international conference on designing pleasurable products and interfaces (DPPI'03)*. ACM Press, New York, NY, 2003, 109-113.

[4] Bruner, J. The narrative construction of reality. *Critical Inquiry,* 18, 1 (1991), 1-21.

[5] Chalmers, M. & A. Galani. Seamful Interleaving: Heterogeneity in the Design and Theory of Interactive Systems. In *Proc. of ACM DIS 2004*. ACM Press, New York, NY, 2004, 243–252.

[6] Cooper, M.D., Foote, J., Girgensohn, A., and Wilcox, L. Temporal Event Clustering for Digital Photo Collections. In *Proc. of Multimedia 2003*. ACM Press, New York, NY, 2003, 364-373.

[7] Counts, S.J., Fellheimer, E. Supporting Social Presence through Lightweight Photo Sharing On and Off the Desktop. In *Proc. of CHI '04*. ACM Press, New York, NY, 2004 599-606.

[8] De Michelis, G.The Swiss Pattada: designing the ultimate tool, (with original drawings by Marco Susani), *Interactions, 10(3)*, (2003), 44-53.

[9] Dourish, P., and Bellotti, V. Awareness and coordination in shared workspaces. In *Proc. of CSCW'92*, ACM Press, New York, 1992, 107-114.

[10] Frohlich D, Kuchinsky A, Pering C, Don A, Ariss S Requirements for photoware. In *Proc. of CSCW'02*, ACM Press, New York, NY, 2002, 166-175.

[11] Kindberg, T., Spasojevic, M., Fleck, R., Sellen, A. The Ubiquitous Camera: An In-Depth Study of Camera Phone Use. *IEEE Pervasive Computing 4(2)*, 2005, 42-50.

[12] Koskinen I, Kurvinen E, Lehtonen T-K. *Mobile Image*. IT Press (2002), Helsinki, Finland.

[13] Mäkelä A, Giller V, Tscheligi M, Sefelin R Joking, storytelling, artsharing, expressing affection: A field trial of how children and their social network communicate with digital images in leisure time. In *Proc. of the CHI'00*. ACM Press, New York, NY, 2000, 548-555.

[14] Ochs, E. and Capps, L. Narrating the self. *Annual Review of Anthropology, 25* (1996), 19-43.

[15] Oulasvirta, A., Tamminen, S., Roto, V., and Kuorelahti, J. Interaction in 4-second bursts: The fragmented nature of attentional resources in mobile HCI. In *Proc. of CHI'05*, ACM Press, New York, NY, 2005, 919-928.

[16] Qian, Y., Feijs, L. Exploring the Potentials of Combining Photo Annotating Tasks with Instant Messaging Fun. In *Proc. of MUM2004*, ACM Press, New York, NY, 2004, 11-17.

[17] Russell, M., Streitz, N., Winograd, T., Building Disappearing Computers, *Communications of the ACM* Vol. 48, No. 3, (2005).

[18] Sarvas, R., Viikari, M., Pesonen, J., Nevanlinna, H. MobShare: Controlled and Immediate Sharing of Mobile Images, In *Proc. of Multimedia 2004*. ACM Press, New York, NY, 2004, 724-731.

[19] Sarvas, R., Herrarte, E., Wilhelm, A., Davis, M. Metadata Creation System for Mobile Images, In *Proc. of MobiSys 2004.* ACM Press, New York, NY, 2004, 36-48.

[20] Shen, C., Lesh, N., Vernier, F., Forlines, C., Frost, J. Sharing and Building Digital Group Histories. In *Proc. of CSCW'02*, ACM Press, New York, NY, 2002, 324-333.

[21] Suchman, L., Located accountabilities in technology production. In: *Scandinavian Journal of Information Systems 14(2)*, 2002, 91-105