

Managing Social Adoption and Technology Adaption in Longitudinal Studies of Mobile Media Applications

Bram Lievens^{*1}, Nataša Milić-Frayling^{†2}, Valentine Lerouge^{*3},
Jo Pierson^{*4}, Gerard Oleksik^{‡5}, Rachel Jones^{‡6}, Jamie Costello^{†7}

^{*}IBBT-SMIT
Vrije Universiteit Brussel Pleinlaan 2
1050 Brussel, Belgium
+32 2 629 1665
{¹bram.lievens, ³smit,
⁴jo.pierson}@vub.ac.be

[†]Microsoft Research
7 JJ Thomson Avenue, Cambridge
CB3 0FB, United Kingdom
+44 1223 479 700
{²natasamf, ⁷v-jcoste}
@microsoft.com

[‡]Instrata Ltd
12 Warkworth Street, Cambridge
CB1 1EG, United Kingdom
+44 1223 301 101
{⁵racheljones, ⁶geoleksik}
@instrata.co.uk

ABSTRACT

In this paper we present a case study of a longitudinal in-situ observation that involves a new social application for mobile communication. Our study demonstrates the need for an adaptive approach to planning, design, and implementation that is responsive to emerging social and infrastructure conditions. This represents a shift from traditional longitudinal studies that observe prototype systems with fixed sets of affordances. In the case of mobile and social applications there is a complex interaction between the social dynamics, the new technology, and the mobile infrastructure. Exploratory research thus requires approaches that can deal with such complex conditions. That includes a high level of prototype *plasticity* to ensure adoption and sustained use that is needed for longitudinal in-situ research. The social aspects dictate specific forms of instrumentation to enable observation of social interactions and mechanisms to inject the new technology into an existing social and communication ecosystem. Our study demonstrates the evolving use of complementary techniques and in-situ modifications of the prototype to support longitudinal observations in a real setting.

Categories and Subject Descriptors

H.5.m [Information Interfaces and Presentation]:

Miscellaneous; H.5.2 [User Interfaces]: Prototyping, User centered design.

General Terms

Design, Human Factors.

Keywords

Mobile communication, social software, case study, in-situ observations, plasticity, living lab.

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

MUM'10, December 1–3, 2010, Limassol, Cyprus.

Copyright 2010 ACM 978-1-4503-0424-5/10/12...\$10.00.

1. INTRODUCTION

We are witnessing a dramatic increase in the usage of social media, such as Facebook, Flickr, and YouTube, and a wide proliferation of mobile technologies that support consumption of social media on mobile devices, such as iPhone from Apple Inc. A need to innovate and define new concepts for social and mobile applications has brought new challenges to the practitioners who wish to explore them through longitudinal in-situ observations.

Generally, introduction of new concepts suffers from the lack of users' familiarity with the new application and functionality, the technical issues of early prototypes, and the upfront infrastructure cost of the prototype installation. In particular, these factors affect the studies of social applications that rely upon an adequate level of adoption in order to observe effects of new concepts. When the social application is strongly tied with the mobile platform, the issues are further amplified by the complex interaction between the social dynamics, nascent technology, and mobile infrastructure. Exploratory research thus requires approaches that can deal with uncertainty and complex conditions.

Conducting user studies of mobile applications present methodological difficulties due to many factors, including the privacy considerations and the lack of fixed locality to support observation, probing, and analysis in natural settings ([12][11]). This is somewhat easier in instances when the user experience has been first shaped and understood within a broadly used desktop environment and then extended to mobile devices, as in the case of email or Web browsing. However, the mobile born applications that are also social in nature, such as Foursquare (<http://foursquare.com>) or Twitter (<http://twitter.com>), raise the complexity of the HCI explorations to another level. First, they initially do not have a critical social mass and a supporting ecosystem and, second, they deal with both social and personal mobile experience.

In this paper we present a case study that illustrates several distinctive issues and learnings from a longitudinal, in-situ observation of the mobile media exchange through a new prototype service, weConnect (<http://weconnect.co.uk>). weConnect introduces a concept of *personal media channels*, akin to Twitter's *tweets* but with rich media affordances and sophisticated client applications for both desktop and mobile devices. In contrast to the simple text tweets and familiar SMS

input technique, weConnect users had to learn a specific way of creating media *mixes*. They also had to become comfortable with incorporating a new way of communication within established social and personal relationships. At the time of the investigation, most of the users were not used to accessing and exchanging media through mainstream mobile devices due to the cost or lack of available services such as WiFi access, GPRS or 3G.

In order to mediate these issues, we resorted to the ‘futuristic’, nevertheless natural setting of a ‘living lab’ which supports explorations of concepts that are ahead of the curve in technology and user practices. We describe in detail our approach to the longitudinal study design that adapts to the changing interaction between the infrastructure conditions, social behavior, and the research discovery process and offer two important insights.

First, the complexity and uncertainty surrounding deployment of a novel mobile social application require an evolving set of objectives and investigative methods. That, in turn, dictates a high degree of *plasticity* of the prototype in order to become a sustainable social application. In that respect, our approach is applicable to HCI objectives that are focused on *understanding higher level properties of the concepts* rather than specific implementation aspects since these may evolve. Therefore, the meaning of the user centered design is taken to another level by becoming an integral part of the study process, fundamental to the ongoing adaptation and adoption of the application. This approach can be used to support iterative application development but should not be equated with such activities since those often lack active engagement of the users and exploratory objectives.

Second, the social aspects require a strong emphasis on instrumentation in order to observe social interactions and facilitate prototype adoption. Indeed, it is critical to devise effective mechanisms to introduce the new application into an existing social and communication ecosystem and achieve the level of adoption that can reveal the impact of technology on the social dynamics and practices.

In the following sections we provide the context of the study, reflect on the related work, and describe the study implementation in detail. We conclude with the discussion of the study implications and the summary of our observations.

2. RELATED WORK

Literature on HCI methodologies has confirmed the value and importance of the field work for evaluating mobile systems and technologies ([14][18]). While lab based approaches are informative and have been expanded to represent mobile environments more adequately [9], they are removed from the intended contexts and natural use. Thus, new approaches have emerged in response to the challenges of mobility. Hagen *et al.* [11] provide a framework that groups them into *mediated data collection, simulations and enactments*, and hybrid approaches that combine them with traditional techniques. The first, mediated data collection approaches comprise methods that engage participants and technology in data collection, e.g., through self-reporting and diaries, data logs, video observation through wearable devices, etc. Such methods overcome a number of difficulties in the contextual evaluation of mobile devices and gather data without the researcher’s presence. *Simulations and enactments*, in contrast, are typically lab based and use role

playing through the enactment of scenarios, or lab props to recreate contexts of use.

Kjeldskov and Graham [14] classify the purpose of research into *understanding, engineering, re-engineering, evaluating, and describing* and map out research methods that have been used to achieve each specific purpose. By reviewing publications in mobile HCI, it became evident that research dedicated to engineering involves field and case studies in only 13% instances. Evaluative research is strongly biased towards lab experimentation, with 71% of all efforts in that category, 19% field studies, and 10% surveys. Thus, the field studies are still relatively rarely undertaken and the majority of engineering occurs without reference to real use contexts. Kjeldskov and Graham [14] argue for a concerted effort to ground engineering and re-engineering in the field and case studies that can provide a richer and contextually relevant input to the process.

Hagen *et al.* [11] note that the most effective evaluation methods for mobile devices employ a range of techniques, each eliciting a particular type of data and contributing to the overall analysis. However, while research questions and hypothesis can be defined in advance, it is not always easy to foresee the best method to answer them. Mobile user research, in particular, is often affected by factors that are difficult to anticipate. De Sa *et al.* [5] thus propose a framework to enable designers and participants to perform low overhead, in situ modifications of mobile prototypes and support iterative and participatory design in the field.

With the emergence of social software there is a further need to develop methods to capture and explain individuals’ behavior in their social context. Indeed, in addition to the HCI issues with technology, we need to observe social interactions among individuals that are facilitated by the technology.

Our longitudinal in-situ study of weConnect enhances the body of field research with new insights into the type of methods that are needed to explore new social and mobile services from the onset of their deployment. We show how in-situ modification arises as the fundamental requirement for service sustainability and longitudinal observations [5]. We also demonstrate the use of complementary techniques, as suggested in [11]. Most importantly, we identify the *plasticity* as the primary principle of the research approach. Plasticity is essential for the long-term prototype deployment in a real context, where the control over the infrastructure and usage is low and the uncertainty about the execution of the study is high.

3. BACKGROUND

3.1 Communication and Social Engagement

The notion of social engagement is commonly associated with social network sites such as Facebook, Del.icio.us, LinkedIn, Yahoo! Answers, and similar. With the popularity and large scale adoption of these services, research is typically focused on understanding the influence of design on the overall usage patterns by the community [23]. However, personal communication is an essential aspect of the social engagement. This is particularly apparent when applications are not designed to support social engagement but the users apply them in creative ways to achieve the sense of connection with a group or a broader community.

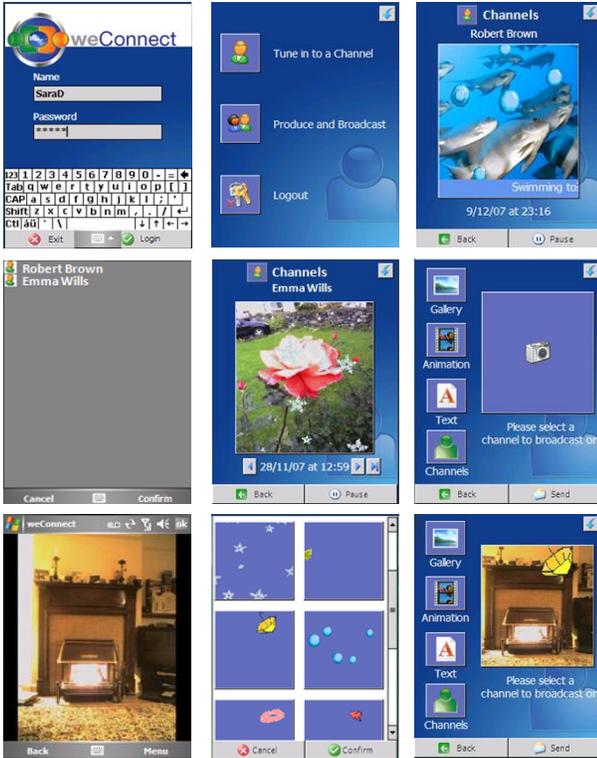


Figure 1: weConnect mobile client enables: user login, viewing or producing a mix to broadcast, and viewing channel (top row). One can view received mixes or create a mix, e.g., by using an taking a new photo, adding animations and text, and then transmitting (middle row). The photo can be enhanced with animated overlays and text (bottom row).

For example, parallel messaging via instant messenger is used to create an affective atmosphere that contributes to the feeling of social connection [17]. Conversely, the community engagement in Facebook, is primarily used for personal communication, keeping in contact with high-school friends, shaping relationships that might otherwise remain ephemeral, and maintaining current relationships [6], similarly to the practices with instant messaging [10]. Social and communication come together most notably in the social software for mobile devices, increasing the social connection and activity levels [4][12]. There the boundary between on-line, mobile, and direct communication is blurred.

3.1.1 weConnect

weConnect is an exploratory research prototype that introduces a notion of the *personal media channel* and enables individuals to share content on a continuous basis with remote others [16]. It aims to explore ways of communicating and sharing experiences beyond the commonly used e-mail, SMS and MMS messages or through fully synchronized communication via IM and phone calls. It supports *unicast* channels that one can create to transmit content to another person—somewhat similar to an RSS feed.

These personal channels are one-way only and, by default, not visible to others who are not involved in the communication. A person can have exclusive channels with as many people as they wish. Similarly, the recipients can reciprocate through a separate channel back. weConnect can therefore be characterized as a

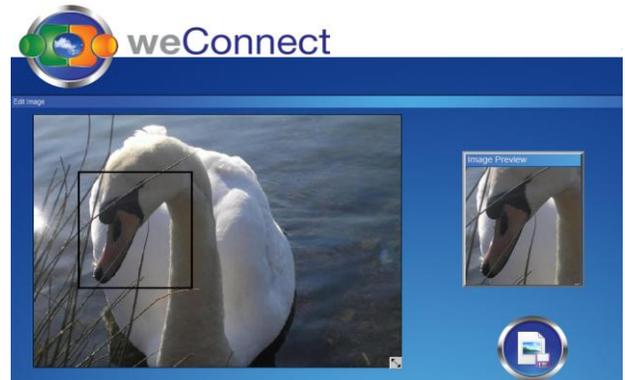


Figure 2. weConnect personal media gallery (top) contains images that are stored on the desktop or sent from the weConnect mobile interface. It provides an easy access to media that has been used through the mobile phone. The user can easily resize and crop an image using the weConnect editing tool (bottom).

‘closed’ social application that enables individuals to attend to their close personal relationships within the social environment. This design fosters the use of mobile phone and the Internet to establish the social co-presence in a range of social and functional scenarios. Similar has been observed by Peters and Allouch [21].

The question arises what role weConnect channels might assume, what practices will evolve, and what types of relationships would benefit from it. According to Palen *et al.* [20], one expects that emerging practices would be influenced by the social contexts. The work by Boase [2] also points out that the choice of technology is likely to be based on the suitability with regards to the existing *ties* with individuals involved in the communication.

3.1.2 weConnect Architecture and Applications

weConnect comprises a Web server that manages the user registration and the media ‘mixes’ sent through individual channels. The Web server is accessible to mobile devices, e.g., C500 Smartphone and PDAs, via GPRS connection, and to the desktops and other devices enabled with the Internet connectivity. weConnect includes two sets of client applications: for *creating* media ‘mixes’ from images, text, and animation overlays and for *viewing* the content of individual channels. Both functions are available on the mobile devices and the weConnect Web interface.

A typical usage scenario involves a user taking a photo on the mobile device, adding text and animations, and then sharing that

media mix with another person through a dedicated media channel. The recipient views the content on a mobile device (Figure 1). Similarly the user can create content using desktop computer. The user logs into the weConnect web site (www.weconnect.co.uk) and accesses personal image gallery with simple tools for editing images. The user can select animation effects to be overlaid over the image and add text that would appear as an animated banner at the bottom of the image (see Figure 2). Such a created mix can be pushed to the specific person's channel by selecting the person from the contact list.

The weConnect Web server stores the media mixes and provides a gateway to the recipient. The recipient's device automatically 'pulls' the content from the server and displays it on the mobile phone, desktop, or any Web device with the weConnect viewer. On the desktop, the content appears within a window of fixed dimensions that can be placed anywhere on the desktop (Figure 3). The user can view multiple channels at the same time, in separate weConnect viewers.

3.1.3 Short-term Field Study

An earlier version of weConnect was subject to a two-week field study that assessed the appeal, observed usage, and provided insights about usability aspects [16]. The study was conducted in a natural setting but for a relatively short period of time and a small sample of users. Thus it left a number of open questions. Could weConnect provide a sustained value and motivate a continued use over time? Could we scale up its deployment to a wider population? Can we conduct successful investigation in spite of a non-standard client application and infrastructure that is not yet main stream? These can be answered only through a longitudinal in-situ study. Here we use the weConnect longitudinal study to examine the methodology for conducting in-situ explorations of the social and mobile applications.

3.2 Longitudinal In-Situ Evaluation

Deployment of research prototypes is often more complex than beta releases of existing products that have an established user base, developed common practices, and a supportive ecosystem. weConnect prototype was designed to facilitate Internet based connectivity on mobile devices and personal computers (PCs). At the time of the study, in 2007–2008, the smartphones were not yet widely deployed, social network applications were still emerging, and the mobile internet connectivity was rather rare. Furthermore, weConnect used the proprietary client applications for the PDAs and desktops that users needed to install and upgrade over time. Finally, the study required access to communities in their natural setting to observe how people developed genuine personal relationships. These requirements led us to the *living lab* environment as the framework for our longitudinal observations.

3.2.1 Living Lab Study Framework

A living lab typically involves a geographic locality, equipped with a required infrastructure and involving a segment of local population that is willing to experiment with new technologies and participate in user trials. For our study we sought partnership with the i-City Living Lab¹ in Hasselt, Belgium (here referred as the Living Lab) and formalized our engagement as *the Living Lab*

¹ i-City Living Lab has become a part of iLab.o, the living lab facility of the IBBT (<http://www.ibbt.be/en/ilabs/ilab-o>).



Figure 3. weConnect desktop viewer for media channels. The user logs in to access personal channels that others have created for him or her. From the drop-down list the user selects the particular channel to view (top row). The text is shown as animated banner, scrolling from right to left. The user can access and replay previous mixes (bottom) through the menu that appears on mouse hover.

Exploration of the Community Sharing (LLECOS) study. The Living Lab provided the facilities to support the design, development, deployment, and evaluation of communication technologies and services in different stages of maturity ([1] [22]).

A choice of a specific living lab inevitably has implications on the design of the software and the deployment strategy. In our case, it meant integrating the weConnect services with the Living Lab wireless network infrastructure, the application management services, the user recruitment services, and the specific PDA devices that were in use by 700 individuals within the Living Lab community. As part of the planning process, we had to assess the risk or our commitment to the Living Lab specific framework. For example, we were aware that deploying weConnect on the Living Lab PDA devices, instead of the users' personal mobile devices, provides the benefits of convenient dissemination and upgrades of mobile client applications. However, it potentially undermines the adoption, considering that mobile phones are perceived as highly personal communication device in contrast to the provided PDAs.

4. LLECOS CASE STUDY

Because of the inherent uncertainty about the deployment and adoption, we planned the study in an incremental fashion. In the remainder of the paper we present the resulting sequence of research stages with details of methods and findings. As we progressed with exploring research issues, we investigated various aspects of weConnect technology through (see Table 1):

- Stage 1: Testing and usability feedback
- Stage 2: Deployment and log analysis
- Stage 3: Diary study
- Stage 4: E-mail integration.

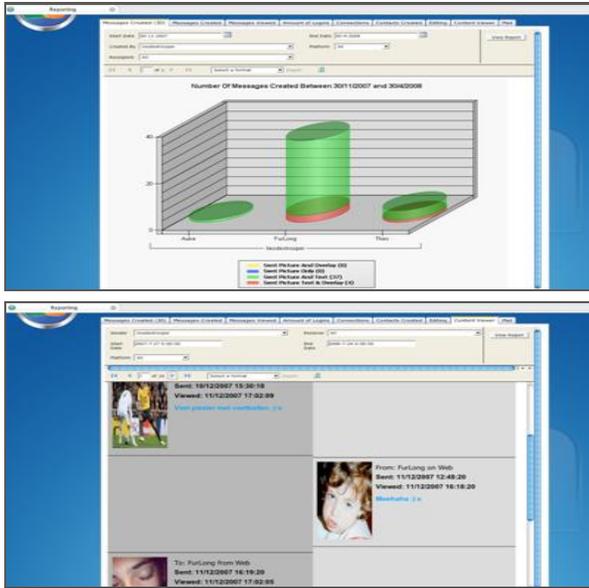


Figure 4: Automatic logging and reporting of weConnect activities across users (top), including details of shared content through personal channels between two individuals (bottom).

Partially overlapping with the stages 3 and 4, we conducted a co-design workshop to explore the fundamental idea of weConnect through photo elicitation and participatory design. While this provided valuable input for future design of weConnect, it did not affect the technology development and research questions during the study. Thus, we defer the details to future publications.

The initial research context was set with the high level research questions: *What is the impact of rich, multi-layered, and continuous personal media on close relationships within social groups? How would close relationships change with the use of such technology?* Our initial hypotheses were:

- H1. The predominant use of WeConnect will be as the means for creating a virtual co-presence.
- H2. Perceptions of the weConnect application will be formed by the characteristics of the social groups.
- H3. The nature of the relationship among individuals will affect the content and purpose of the created weConnect mixes.
- H4. weConnect will add to the group dynamics within existing communities.

In the following sections we describe individual stages, reflecting on the reasons for their occurrence and the outcomes they led to.

4.1 Testing and Usability Feedback—Stage 1

The first step involved integration of the weConnect service with the Living Lab environment. That called for usability testing and was conducted by involving members of the Living Lab staff and the extended research team². Our aim was to identify and rectify obvious technical and usability issues. The participants were asked to try the service for several days and provide feedback.

² Researchers from the IBBT-SMIT Research Centre from Vrije University, Brussel and Microsoft Research Cambridge.

Table 1. Study Timeline

Stage 1. Testing and Usability weConnect v.1		
Sept'07	Usability Test-City LLab	Liv. Lab Eng. Staff
Stage 2. Deployment and Log Analysis, weConnect v.2		
26 Oct'07 - 12 Nov'07	Online survey	Couples, Friends, Colleagues
6 Nov'07 - 19 Nov'07	Introductory Interviews	Couples, Friends, Colleagues
1 Dec'07 - 19 Dec'07	Online survey	Community members
18 Dec'07 - 18 Dec'07	Introductory Interviews	Community members (9 p.)
Stage 3. Diary Study, weConnect v.3		
12 Dec'07 - 20 Dec'07	Re-introduction and distribution of diaries	Couples, Friends, Colleagues
28 Dec'07	Re-introduction and distribution of diaries	Community members (4 p.)
23 Dec'07 - 18 Jan'08	Completing diary	Couples, Friends, Colleagues
16 Jan'08 - 23 Jan'08	Completing diary	Community members
20 Feb'08	Telephone feedback (diary + application)	Community members
Stage 4. E-mail Integration (in parallel with co-design workshop , weConnect v.4		
2 Apr'08 - 15 Apr'08	In-depth interview (diary + e-mail service)	Couples (4 p.) Friends, colleagues
10 Apr'08 - 14 Apr'08	In-depth interview (diary + e-mail service)	Community members (5 p.)
25 Apr'08	Telephone feedback (e-mail service)	Community members

4.1.1 Software Modification – weConnect V.2

As a result of the initial feedback, we made several changes and released weConnect V.2. The website was given a new look. Legal documents were added to clarify privacy issues and the terms of personal and non-commercial use of the service. Online help and contact e-mails were included to help users and reduce the failure rate. Most importantly, the client software was enabled to connect to the service automatically once the user has logged onto the PDA. This reduced the need for multiple logging. Finally, the logging infrastructure was expanded to support analyses of the service logs through pre-defined reports and enabled easy monitoring of the usage (see Figure 4).

At that point we also made a conscious decision not to make design changes in response to two suggestions:

Notifications. The participants suggested notification for incoming content. Since our intention was to explore the nature of an 'always on' live channel we did not expose information about arrival of mixes. However, we added a 'history' feature, enabling users to review previously received media mixes (Figure 3).

Differentiation. The participants did not see added value in weConnect since it was restricted to the image data. However, we decided to stay with the use of images, text and overlay since those content types were readily available and required no

significant departure from the current user practices. weConnect could support editing and streaming of video and audio content but we assumed that the familiarity and reduced technical complexity would create lower barrier for adoption.

4.2 Deployment and Observations—Stage 2

Recruitment of the study participants was most essential in this stage of the LLECOS study. These users were to assume a dual role: as subjects of the study and as ‘seeds’ for spreading the service throughout the community. We aimed at a diverse sample of participants along several dimensions: age, gender, profession, belonging to a social network, and communication habits.

In order to ensure adoption, it seemed most promising to focus on users with strong ties. People with strong ties influence each other to adapt and expand their use of media [13]. They typically use diverse media for different types of messages. The tie strength can be measured through various characteristics: the amount of time people spend together, the frequency of contact, the emotional intensity, the intimacy, and the reciprocal services ([8][15][13]). Granovetter [8] distinguishes between three types of ties in a community: *social*, *community affairs*, and *business-professional*. The social ties function as strong ties, business-professional are weak ties, and community ties are in between [9]. Introducing a new social medium into a community may facilitate creation of new social ties [13] and, conversely, strong social ties may facilitate the adoption of the new technology.

Furthermore, we were interested in people aged between 16 and 40, anticipating that they are more familiar with new applications such as mobile phones and PDAs with camera. That age group is also known to make use of technology for various reasons, including personal, functional, emotional, and practical [19].

4.2.1 Participants

Throughout the project we engaged 33 participants in different phases, among them 23 males and 10 females. The average age of participants was 24. Most (24) were still studying, mainly at the university of Leuven or Hasselt, while nine participants were employed in different companies.

Couples, Friends, and Colleagues. We recruited five social groups based on their relationships (Table 2). All the participating groups involved individuals who had registered with the Living Lab. That was the only common background they shared. They never met members of other groups and during the study they were interviewed only within their group’s context.

Community. We opted for the student organization Filii Lamberti, associated with the Faculty of informatics, mathematics and natural sciences at University of Hasselt. We recruited 14 members to participate in the study. All of them lived in the dorms during the week and with parents on weekends, except for Wouter who lived with his fiancée. Six recruited members were in a romantic relationship at the time of the research.

4.2.2 Introductory Interviews

During the study we conducted three in-depth interviews with each participant. The first set of interviews was video recorded. The objective was to receive more detailed information about the participants, introduce them to the weConnect application, and observe their first reaction to the prototype.

Interviews with individuals, couples, and friends were held between November 6’07 and November 19’07. Interviews with

Table 2. Couples, friends and colleagues participating in the study

Name	Sex	Age	Profession	Relationship	
Lien	F	21	Student	Couple - not officially* living together	
Kris	M	34	Employee		
Sarah	F	41	Employee	Couple – two children	
Frans	M	37	Employee		
Filip	M	22	Student	Couple - not living together	Friends
Florence	F	21	Student		
Julie	F	20	Student	Couple - not living together	
Joost	M	21	Student		
An	F	32	Employee	Colleagues - Friends	
Pauline	F	37	Employee		
Nathalie	F	31	Employee		

*Officially not living together refers to couples who spent most of the time together, during the week and weekends, but resided at different addresses.

the community members took place on December 18’07 and December 28’07. In order to make them engaging and informative we used a concept map as a means of gaining a shared understanding about common concepts [7]. During this first meetings, the participants were shown a demonstration of the software and given a list of instructions how to download the software to their mobile devices and the desktop.

4.2.2.1 Users’ First Impressions

The introductory interviews provided good insights into the users’ perception of the prototype prior to having a chance to try it for personal use. While we introduced weConnect as a broadcast medium for creative and personalized content, the participants perceived it as a *personal communication tool* that could be used in a private context. The concept of a channel for broadcasting multi-layered content did not resonate with them since the implementation resembled other mobile communication technology such as MMS. They anticipated that weConnect would be taken up mostly by female teenagers. They themselves did not feel a need to add it to their current choice of communication technologies.

Some participants perceived the one-to-one aspect of weConnect as a positive element while others saw it as restrictive. While weConnect enabled special connection between two individuals, some users anticipated a need to share the same mix with others at the same time. This was pointed out several times by community members who liked sharing things that bond them, like parties:

‘It could be more community based. That you could create one folder with all the pictures you’ve taken at a party last night. The people, who joined your contact list, could view the pictures you’ve uploaded.’ (Karl, male, 23)

We discussed a hypothetical scenario of ‘someone wanting to share a moment’, creating a mix, and pushing it through the channel. The participants did not expect that to be put into practice because of the complexity of the application. They

expected weConnect to be used when people have time, mostly over weekends, during leisure time, or situations when there is nothing important or interesting to do (e.g., waiting for a train). The Internet connection was another factor expected to influence the use rate since it was required in all stages of media sharing:

'You'll have to search for a reliable wireless internet connection. The amount of such connections is sometimes too limited.' (Florence, female, 21)

The participants expected that the potential recipients of the weConnect content would be among their personal network, i.e., friends, family, and partners. Some expected to use it for sharing contextual information, i.e., experience, while continue to use other technologies for practical information. Furthermore, they expected to send wishes and greetings that they normally send via text message, post, or e-cards.

'I would use the application on birthdays, Christmas, New Year. Or if I've taken a very good and funny picture' (Florence, female, 21)

Others expected to share pleasant experiences with those who are not around at the time (i.e., establish a virtual co-presence). Party images, pictures of the children to the husband who is away, etc., are examples of these. The participants did raise the issue of the risk of missing a mix due to the lack of notification and pointed out that this will prevent usage for time critical media exchanges.

4.2.3 Log Analysis and Second Interviews

Analysis of logs during November'07 and December '07 showed very little user activity. We revisited our technology introduction approach and decided to attempt a more hands-on and structured training. We scheduled another set of face-to-face interviews for December 19-20'07, i.e., within five weeks of the service introduction. The interviews revealed a number of critical issues: (1) too few wireless access points to the Internet, (2) problems downloading the weConnect desktop player, in some instances due to the high security settings on the PC, (3) complex UI on the mobile and desktop, (4) no status indicators when sending and receiving content, and (5) platform incompatibility, i.e., most students used Firefox Internet Explorer while weConnect was implemented for MS Internet Explorer only.

The problem of installing the desktop viewer (Figure 3) was particularly acute. The client application used the latest .NET framework which was not pre-installed on the users' computers. Thus, the users had to take an extra initiative to find the right version of the .NET framework on-line and install it before they could use the desktop client.

4.2.4 Service Modifications – weConnect V.3

In response to the findings, we released weConnect V.3 that included the link for downloading the supporting software (.NET framework), the progress bar to inform about the status of computer operations, and the notification when a media mix was sent. In addition to the hands-on introduction of weConnect features, we provided an online manual in Dutch and English.

4.2.5 Research Questions

We realized that the adoption of the software is heavily undermined by the combination of technical and usability issues. The usability was not limited to the client applications alone but extended to the usability of the service as a whole, including adequate support for the application download and installations.

We were at the second decision point on whether and how to proceed with the study. Without generating a decent level of usage we could not learn from the log analysis. Thus we decided for an alternative approach. We implemented a diary study to collect detailed information about the context in which weConnect would be used. In retrospect, that decision was very beneficial. It focused the participants' attention onto the application and encouraging active usage and engagement.

4.3 Diary Study—Stage 3

During the second interviews we repeated the weConnect introduction. This took place at the end of December'07 for the couples and friends groups and on February 20'08 for the community participants. We also provided each participant with a paper and pencil diary in an A5 booklet format. The diary design was event based, asking the participants to note 'trigger' events related to the weConnect use [3]. Each diary contained 28 event pages. Using a combination of closed and open questions, we tried to reduce the effort of capturing information. With the diary, we also included a brief manual of weConnect features to help participants remember how to use them. By the end of the diary study we received 14 out of 25 diaries.

4.3.1 Diary Findings

From the diaries it became apparent that weConnect is perceived as a personal tool, used in a private setting such as one's living room or bedroom. The diaries also showed the users intentions to reciprocate. The log analysis confirmed that most of the users successfully created media mixes and revealed that the reciprocation was not the primary driver for the media sharing. Similarly to the findings of the short-term weConnect study [16], the participants created various types of content. Predictably, they used weConnect around Christmas time for greetings. The media mixes were sent not only to the participants of the study but also to others who were not actively engaged in the project. However, we did not see signs of significant 'spreading' of the applications. Besides the flurry of Christmas greetings, the only instance in which a participant invited an 'external' person to join the study is by Julie: *"I invited my sister. She uses it because it's fun and can tease me and Joost."* (Julie, female, 21). Others noted that existing communication means were sufficient to connect with friends and family members; thus there was no urge to try something new.

4.3.2 Software Implications – weConnect V.4

In order to compensate for the unreliable wireless infrastructure, the Living Lab provided users with GPRS cards for the PDAs, with unlimited usage. However, this was not effective since the users could not use both the voice and the GPRS on the same SIM card. They had to switch SIM cards in order to use weConnect. At that point it became clear that the mobile connectivity presented an insurmountable issue. Thus, we decided to redirect our investigation of weConnect concepts through desktop media sharing. Still, we faced uncertainty. *Have we gained enough momentum and common knowledge in the community to increase the usage of weConnect? What barriers remain after we remove the mobile infrastructure issues?*

To this effect we introduced two new features: (1) sending media mixes via e-mail and (2) using the Internet browser as the client for viewing shared content. The latter eliminated the need to download the weConnect proprietary client. Furthermore, the recipients of e-mails with imbedded weConnect mixes were

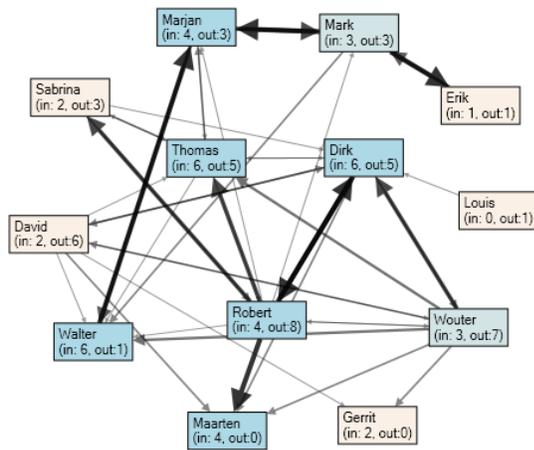


Figure 5. Social network of the Filii Lamberti social group, indicating number of mixes exchanging among the members.

automatically assigned a *‘studio’* space with channels that were created for them by other individuals. They did not need to register in order to view the mixes. Furthermore, they could unlock the channel viewers from the studio and place them on the desktop. They could view any number of channels at one time.

4.4 E-mail Integration—Stage 4

4.4.1 Final Interviews

The weConnect e-mail service was rather transparent and most participants knew immediately how to use it. The studio and the ability to drag different channels onto the desktop, gave the participants a feeling that they are connected to several individuals at once. Most participants tuned into different channels occasionally. Many pointed out a need for notification of content arrival. The lack of notification obliged them to tune into the application even when they have not received a new mix. That turned out to be a cause of low activity and missed content. Many mixes, although sent earlier, were shared face-to-face, i.e., the people viewed the content when they encountered the sender: *‘There was a good chance that we saw each other face-to-face before we looked at the new mix’* (Kris, male, 34).

The participants made suggestions to expand the application with personal overlays, voice messages, and existing communication channels (e.g., Windows Live Messenger). Many intended to share media amongst people outside the study. However, it turned out that some e-mail accounts had high security levels. Thus, recipients received only a part of the mix or the mix would disappear into the spam folder. Participants who experienced these problems stopped using the service.

We held separate interviews with smaller subgroups within the community group. They were selected on the basis of friendship ties and the messages they have exchanged with each other. The strength of the friendship tie was measured through the online questionnaire at the beginning of the study (*‘who do you like most within the community?’*). Those closely related individuals were affected by the high activity rate (Figure 5). However, the use of the weConnect application did not necessarily strengthen weaker ties. Community members who were generally *‘not so popular’* and attempted to create a channel with more prominent individuals were not reciprocated. The communication between two such members stayed restricted to face-to-face contact.

Finally, we noted the emergence of the community effect in knowledge propagation and support. For non-technical individuals the weConnect application seemed too complicated. They depended on the technical knowledge of the surrounding network. *‘It was really frustrating because I couldn’t sort it out. Anne explained it to me again. They sent me different mixes and I never received them. Very frustrating’* (Pauline, female, 37).

4.5 Summary

Reflecting on the research questions and hypothesis in Section 4, the study has shown that:

- weConnect was used as a tool for establishing virtual co-presence. The mixes that were sent during the LLECOS study embedded personal and contextual information.
- The perception of weConnect across social groups did not vary significantly. The participants had a uniformed view of weConnect as a personal communication tool. As such it did not add value compared to existing applications. Nevertheless, the users asked for the expansion to community channels but did not want to be connected continuously; thus requested notifications of received content.
- The participants’ relationships did affect the content and the purpose of the media mixes. Particularly interesting were observations of community members who exchanged a range of mixes, from personal content to community events that were of broader interests.
- weConnect did not affect the group dynamics within the larger community group: it seemed to have strengthened the strong ties but has not improved the weak ties.

Our method of multi-stage technology and research adaption enabled us to carry out investigations and ensured sustainability of the user engagement. It provided a dual benefit. First, at every stage we gained a deeper understanding of the usage scenarios and expanded the prototype to increase its compatibility with the user environment. Second, in the process, we gained insights into the deployment and adoption issues that are essential for the evolution of the mobile social applications and their productization strategies.

5. DISCUSSION

The LLECOS case study shows that setting up a longitudinal in-situ study of a mobile application in a social context is not a simple extension of a standard field study. One has to account for:

- (1) High influence of the extended infrastructure on the prototype itself. Both the maturity of the prototype and the availability of the required infrastructure must reach a level that makes the deployment and the longer-term use feasible.
- (2) High barrier for social adoption within a mature ecosystem of applications and services. This includes the expectations from the prototype to add value and replace or fit alongside the established practices that involve products already available in the market place.
- (3) Mechanisms that are needed to sustain visibility and promotion of the prototype within the community, as is normally achieved through marketing campaigns and incentives for trying a product or a beta release.

- (4) Uncertainty and unpredictability of the technical and social conditions that increase with prolonged explorations within complex environments. Global planning is impractical. The strategy and the plans for intervention evolve with the study.

Through the case study we illustrated how these factors are counteracted by an adaptive approach to research planning and the in-situ evolution of the exploratory prototype that is continually adjusted to meet the social and platform constraints.

Implications of social aspects. In contrast to applications that do not incorporate social aspects, the deployment and investigation of social applications suffers from uncertainty about the adoption and social interactions that may ensue and needs to be observed. Furthermore, the participants registered for the study may engage with non-participants that are drawn into the study through the openness of the system. This has further implications on the privacy and legal aspects of the study management. Taking a restrictive approach and limiting the social engagement of the participants may seriously undermine the exploratory objectives of the study. Thus, the 'unbounded' nature of the social interaction demands changes in the approaches to the study planning and management.

In the case of the LLECOS study, the social circles reached beyond the Living Lab setting through the email distribution and required instrumentation of the application to accommodate a growing set of study participants.

Implications for the qualitative and quantitative research. The changing nature of the study design had direct impact on the research methods. They were strongly shaped by three factors: the user sampling, the type of collected data, and the evolving discovery process. Indeed, the initial reliance on the Living Lab framework guided us towards purposeful sampling. The analysis of the user logs in the deployment phase informed the methodology for further data collection, i.e., by complementing interviews with the diary study. Then by combing the diary data with the logs we gained new insights and set off to expand the investigation outside the original weConnect framework, extending it to e-mail.

This process illustrates both the role of quantitative and qualitative research in shaping the study and, at the same time, their modification to provide the basis for the next phase and new methodology.

Platform considerations. In the study we had to migrate the application from a primarily mobile experience to the desktop with a Web client as a consequence of the technical infrastructure and usability issues. The need for such a platform shift may be driven by various factors. In our case we detected a general market inability to absorb applications like the weConnect desktop viewer due to the early stage of .Net adoption. Thus, the prototype dependence on a technology that is not prevalent becomes a limiting factor in the application dissemination and adoption. Fortunately, the change of our emphases from the mobile to the Web client did not affect the back-end service and the essential monitoring of social interactions.

Plasticity of prototype and method. From the perspective of prototype design, it is important to enable swift response to the field findings and factors that may affect the sustainability of the prototype use during long-term investigation. This implies a high level of plasticity to enable efficient transformation of the

prototype for the next phase of the concept investigation. It also requires the team's agility to apply new investigative methods and techniques to achieve research objectives.

In the case of weConnect we first modified the original weConnect service and the client applications to integrate with the PDA platform of the Living Lab. In the following phase we incorporated an e-mail service and added the *studio* space for non-registered users. Both interventions were in response to the infrastructure conditions and necessary for the key objective to investigate personal, always-on media channel for use in the social context. In response to the usability feedback, we expanded the media viewer to enable review of previously received media mixes. However, we were careful not to make modifications that would change the core of the concept we are investigating, i.e., the always-on channel of personal media.

Perhaps, more importantly, the LLECOS study demonstrates the agility of research methodology and evolving use of complementary techniques. Initially we opted for a hybrid approach of log analysis and face-to-face interviews and then expanded with a diary study that has proven beneficial from the perspective of both data collection and the adoption and usage.

Driving social engagement and adoption. In retrospect, we realized that the challenges of investigating new concepts through longitudinal deployment of social applications are akin to those of product marketing and deployment. Indeed, the research questions and the prototypes need to withstand the challenges of adoption, investment, and sustainability of longitudinal use. This, in turn, requires consideration of the added value to the users.

In order to increase the accessibility of the prototype, we made the decision to restrict weConnect to sharing photos since personal photos were easily accessible as opposed to personal videos. However, that simplification resulted in the lack of perceived novelty in comparison to the existing applications. Thus, it is critical to achieve the right balance between the added value and the market readiness.

We observe that successful online community services (e.g., MySpace, Facebook) lean towards providing an open platform that enables the community of developers to create new applications and thus bring novelty and freshness into the existing and evolving social media. The adaptive research approach and the plasticity of the research prototypes resemble this process. The essential difference is in the level of market awareness and competitive positioning, the promotional effort, and the emphasis on the immediate and long-term customer value.

Furthermore, with the modern methods of peer-to-peer marketing and advertisement, as evident in Twitter and Facebook, we anticipate that these mechanisms will be used in the future social application deployments to initiate and maintain the awareness of the application. It is likely that they will also be used for direct communication with the participants through the full emersion of the study administrators with the community of the participants.

Team. The study illustrates a tight feedback loop and iterations of the technical development, infrastructure management, prototype design, data analysis, research planning, and communication with the participants and partners. Thus, in contrast to typical field studies, the complexity of the study management is increased due to the cross-disciplinary nature of the work and the importance of including individuals that cover a diverse skill set.

6. CONCLUSIONS

Our case study illustrates a multi-stage adaptive approach to the longitudinal in-situ observations that accounts for uncertainty and reacts to the findings within the social and mobile context. Novel applications which use commercial technologies that are in the early deployment phase, face a lack of adequate mainstream infrastructure. Thus the deployment may need to be restricted to living labs which pro-actively address such issues while maintaining a natural community setting. However, even that approach may not be effective. In our case, the living lab framework has proven insufficient to remove all the uncertainty and technical obstacles, partially because the application spanned multiple platforms that were not all part of the living lab set up.

The social nature of the weConnect enabled us to explore the effect that social aspects have on the exploratory study design. It is obvious that the prototype adoption is an essential prerequisite. However, it is less clear how to balance different factors that drive the adoption, in particular the technical accessibility versus the novelty and appeal of the application. On one side it is important to achieve a clear differentiation from the existing services. On the other, the viral propagation cannot be achieved unless the users can incorporate the new application into their existing practices. In the case of weConnect, we opted to leverage mobile phone photo cameras and restricted media sharing to personal photos; mobile phone video-cameras were not yet mainstream.

While the adaptive approach was successful in achieving the objectives of our explorations, there are many open questions to explore further. Starting with the research agenda, *how far can we formulate the course of investigation when the service adoption is an essential pre-requisite and needs to be achieved during the course of the study?* Indeed, the research objectives require the adoption of the prototype and the adoption affects the community dynamics. Thus, the social experiment and the community become inseparable. In that context, *what is the role of the observers?* Just as ethnographers immerse themselves into physical environments, *should we incorporate the observer's social presence into the design of social applications and services? Should the observers become a part of the community? If so, what is the acceptable threshold of intervention? What is the minimum size of the social circle that could tolerate the researcher's intrusion?* We expect that further experiments with social media environments, such as Facebook and Twitter, will help us answer some of these questions before applying in the user research.

7. REFERENCES

- [1] Ballon, P., Pierson, J., and Delaere, S. 2007. Fostering Innovation in Networked Communications: Test and Experimentation Platforms for Broadband Systems. *In Designing for Networked Communication – Strategies and Development*. IDEA, 137-166.
- [2] Boase, J. 2008. Personal networks and the personal communication system. *Information, Communication & Society* 11(4): 490-508.
- [3] Bolger, N., Davis, A. and Rafaeli E. 2003. Diary methods: capturing life as it is lived. *Annual Review of Psychology* 54 (Feb. 2003), 579-616.
- [4] Counts, S., Ter Hofte, H. and Smith, I. 2006. Mobile Social Software: Realizing Potential, Managing Risks. *In the CHI 2006 Mobile Social Software Proceedings*.
- [5] De Sa, M.A., Carrico, L., and Duarte, L., Reis, T. 2008. A Framework for Mobile Evaluation. *In Proc. of CHI'08*, 2673-2678.
- [6] Ellison, N., Steinfield, C. and Lampe, C. 2007. The Benefits of Facebook Friends: Social capital and College Students' Use of Online Network sites. *J. of Computer-Mediated Communication*. 12, 4 (July 2007), 26.
- [7] Freeman, L. A. and Jessup, L.M. 2004. The power and benefits of concept mapping: measuring use, usefulness, ease of use and satisfaction. *Int. J. of Science Education* 26(2): 151-169.
- [8] Granovetter, M. 1973. The Strength of Weak Ties. *American Journal of Sociology*, 78(6): 1360-1380.
- [9] Granovetter, M. 1983. The strength of weak ties: a network theory revisited. *Sociological Theory* 1: 201-233.
- [10] Grinter, R. E., Palen, L. 2002. Instant Messaging in Teen Life. *CSCW'02*, Louisiana, USA
- [11] Hagen, P., Robertson, T., Kan, M., and Sadler, K., 2005. Emerging Research Methods for Understanding Mobile Technology Use, *In Proc. of OZCHI*, 1-10.
- [12] Ishii, K. 2006. Implication of Mobility: the Use of Personal Media in Everyday Life. *Journal of Comm.* 55: 346-365.
- [13] Haythornthwaite, C. 2002. Strong, weak, and latent ties and the impact of new media. *The Info. Society* 18: 385-401.
- [14] Kjeldskov, J. and Graham, C. 2003. A Review of Mobile HCI Methods. *Human Computer Interaction with Mobile Devices and Services*, 317-335.
- [15] Marsden, P. and Lin, N. 1982. *Social structure and network analysis*. Beverly Hills, Sage.
- [16] Milic-Frayling, N., Hicks, M., Jones, R., and Costello, J. 2007. Exploring Personal Broadcast Channels for Rich Media Sharing in Close Relationships. *In Proc. of the 7th Int. Conf. of Mobile and Ubiquitous Multimedia. MUM'08*.
- [17] Narda, B. A., Whittaker, S., and Bradnew, E. 2000. Interaction and Outeraction: Instant Messaging in Action. *CSCW'00*.
- [18] Nielsen Ch. M., Overgaard, M., Pedersen, M. B., Stage, J., and Stenild, S. It's Worth the Hassle! The Added Value of Evaluating the Usability of Mobile Systems in the Field. *NordiCHI 2006*, 272-280.
- [19] Okabe, D. 2004. Emergent social practices, situations and relations through everyday camera phone use. *In the Proc. of 2004 Int. Conf. on Mobile Communication*, Seoul.
- [20] Palen, L., Salzman, M. and Youngs E. 2001. Discovery and integration of mobile communication in everyday life. *J. of Personal and Ubiquitous Computing*. 5, 2 (June 2001), 109-122.
- [21] Peters, O. and S. B. Allouch. 2005. Always connected: a longitudinal study of mobile communication. *Telematics and Informatics* 22: 239-256.
- [22] Pierson, J. and Lievens, B. 2005. Configuring living labs for a 'thick' understanding of innovation. *In the Conference Proc. of EPIC 2005*, Am. Anthropol. Assoc. USA, 114-127.
- [23] Rodrigues, E. M., Milic-Frayling, N., and Fortuna, B. 2008. Social Tagging Behavior in Community-driven Question Answering. *In Proc. of Web Intelligence Conf., WI 2008*.