The Design, Deployment and Evaluation of Situated Display-based Systems to Support Coordination and Community

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Abstract   In recent years, there has been much interest in the potential for situated displays to support sense of community. In this chapter, we describe our experiences of two significant situated display-based deployments which explore some of the issues that arise when such systems are used on a day to day basis. The first deployment described is that of the Hermes system which has been deployed and evaluated in both a University department and a domestic home setting. The second deployment is the Wray photo display which has been deployed in two locations in a rural village located in the north of England. Both deployments made strong use of user-centered design and have benefitted from longitudinal evaluation in order to provide key insights into issues of adoption and appropriation.

1   Introduction

In Weiser's seminal paper (Weiser, 1991) introducing ubiquitous computing he described how:

> "The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it"

This is perhaps the ultimate design goal for any piece of technology and the most challenging to achieve. So, in order for technologies to effectively disappear they need to be carefully designed such that they cause minimal disruption with the existing practices, and so forth, of a given setting (such as a particular office environment/workplace or a family home etc.).

By depicting settings in this way, it is important to regard them as places and according to Harrison and Dourish (1996) a place is:

"a space which is invested with understandings of behavioural appropriateness, cultural expectations, and so forth"

Consequently, if the practices afforded or imposed by a ubicomp technology deployment do not fit in with associations of a given place which relate to cultural expectations, existing patterns of behaviour, etc., it is more likely that adoption of the technology will be problematic. As a designer/developer of ubicomp technologies it is therefore essential to understand the social and physical richness of a given setting. Typical approaches for understanding settings include ethnographic studies, use of cultural and technology probes, focus groups and design workshops. Iterative methodologies based on a cycle of observation, design and deployment are effective for understanding a given setting prior to deployment, for understanding the adoption of a deployed technology and the need for associated redesign/modifications.

Another factor which may increase the likelihood of successful adoption in a ubicomp deployment is the use of a design methodology that places a strong emphasis on end-user involvement – so called, user-centered design methodologies. Indeed, through approaches such as participatory design (Bjerknes et al. 1987), the end users themselves may be strongly involved in the design process itself.

In the remainder of this chapter, we will focus on our research activities on exploring a particular kind of ubicomp technology – that of situated displays. When we refer to situated displays we agree strongly with the definition provided by O'Hara et al. (2002) and the possibilities they raise:

"At their most basic, digital display technologies allow information to be more easily updated dynamically and remotely. However, these new kinds of interaction technologies also allow people to use these situated displays in novel ways both as for the individual's purposes and in the support of group work."

While these displays are becoming increasingly common as the technology to realise them becomes trivial, most situated display deployments are simply passive advertisements showing slideshows of content despite the potential to offer novel interactions and real benefits to users. It is also important to note the focus on situated displays in this chapter which implies a need to take particular notice of the place of deployment when considering this particular form of digital technology.

In exploring situated displays we have three broad research aims:

1. *Understanding of Settings*. In our research we use ethnographic and related studies (both longitudinal and short term) to understand the social nature of public and semi-public spaces both before and after the introduction of situated display technology. This work involved developing an understanding of the affordances of a given place (e.g. outside an office door or inside a communal living area) to help determine appropriate placement strategies for situated displays and an appreciation of what content may be relevant to display in a given place to facilitate cooperation as well as a sense of community (defined as "the perception of similarity to others... and the feeling that one is part of a larger

dependable and stable structure" (Sarason 1974)) between and within a certain user group.

2. *Exploration of Interaction and Use*. Situated displays do not typically fit the traditional single user mouse/keyboard interaction style. Consequently, we sought to explore the interactions that manifest themselves (over time) in the domain. Much of this exploration was guided by our understanding of the settings and utilised techniques found in context-aware computing (location-aware behaviour, automatic personalisation/content creation based on sensed context, etc.) and tangible interfaces as well as more familiar modalities such as e-mail, instant messaging and mobile phones.

3. *Prolonged Deployments*. A key element of our research methodology is the use of substantial deployed installations. The long term use of novel technologies, especially their collaborative and community effects, cannot be deeply understood through short-term experiments or 'toy' installations. This development and deployment enables longitudinal studies as well as being a technology demonstrator for dissemination and inspiration. It is also important to note that all the deployments described in this chapter run 24 hours a day, seven days a week.

Settings that we have studied as part of our exploration of situated displays have included: the homes of lecturing/research staff, a Computing Department space at Lancaster University, a residential care facility, a University climbing club and a rural village near Lancaster.

In the next section we present relevant related work, and then, in the remainder of this chapter, we focus on the situated display deployments associated with the Computing Department setting (Section 3), the homes of lecturing/research staff (Section 4) and a rural village (Section 5). Following these three sections, Section 6 provides a general discussion on the key challenges that we have encountered during our work on the design and evaluation of public displays. Finally, Section 7 contains our concluding remarks.

2   Related Work

In this related work section we summarise significant past and present research into the use of situated displays designed to facilitate notions of community and categorise this research according to four broad areas according to the type of deployment setting. Section 2.1 discusses deployments in research lab settings, section 2.2 focuses on deployments in university/school settings, section 2.3 focuses on deployments in so-called "Third Places" (Oldenburg and Brissett 1982) while section 2.4 focuses on deployments in rural, urban or developing world contexts. Effectively, the ordering of these sections can be seen as representing deployments in increasingly "wild" settings.

2.1 Situated Displays in Research Lab Settings

Some of the earliest work to investigate the potential of situated displays to support notions of community has taken place in research lab settings. For example, McCarthy's Groupcast system (McCarthy 2003) utilised a large public display coupled with presence-sensing technologies in order to display content of mutual interest to work colleagues as they passed by the display. McCarthy also developed the 'OutCast' system which enables the owner of an office to display content (personal web pages, public calendar entries, etc.) on a medium-sized display touch-screen display situated outside his or her office.

Another piece of work involving a similar deployment in a research lab setting was the Plasma Poster Network (Churchill et al. 2003). This system sought to promote "community information sharing" though a network of plasma displays which effectively acted as 'digital' poster boards. The system was deployed and evaluated over a longitudinal period of time (ten months) at the FXPAL research lab in California, U.S. and this enabled a number of ecologically valid observations to be made. This included observations regarding the appropriateness of content submitted for display.

Brignull and Rogers (2003) have also studied public interaction around situated displays. One of the study settings used was a welcome party for postgraduates entering university in which projection based situated display system was used. The focus of their research was to:

> "provide designers with a framework by which to understand and conceptualise public display-based interactions"

For example, the research involved the use of video cameras to observe the movements of students around the display and so support the analysis of how students interacted with the display in this particular setting and event.

2.2 Situated Displays in University/School Settings

The Notification Collage (NC) (Greenberg and Rounding 2001) groupware system was developed, deployed and evaluated in a university setting by a research group at the University of Calgary. The system enabled distributed and co-located colleagues to post media elements, e.g. sticky notes or video elements, onto a real-time collaborative surface in the form of a large display in a public setting. The surface could also be viewed on personal private displays. Greenberg and Rounding (2001) comment that:

> "we saw that people treated the NC as a virtual room/bulletin board encouraging interaction. One person would post a media element, and others would (eventually) become aware of it and selectively react to it"

In the school environment, the Dynamo multi-user situated display system developed by Izadi et al. (2003) deployed and evaluated in a number of different settings including a sixth form common room. In this setting, it enabled students to submit media to the display and 'carve' specific areas of the public display for more private interactions.

2.3 Situated Displays in "Third Places"

The term "Third Places" refers to places which are not typically associated with home or work activities such as cafes and places where "one may go alone at almost any time of the day or evening with assurance that acquaintances will be there." (Oldenburg and Brissett 1982).

One important deployment in the café space was "Cow Cam" (Sherry 2005) which featured a large plasma display accompanied by a web cam device and a flatbed scanner placed on one of the café tables. The 'Urban Grind' café which is the setting for the deployment is a coffee house located in Portland, Oregon, U.S. One significant finding of this work was the importance of supporting various methods of allowing patrons of the café to contribute content to the display. For example, patrons could use the web cam to take a picture of themselves or scan in an image of a leaflet they wished to advertise using the flatbed scanner.

McCarthy et al. (2009) developed the Community Collage (CoCollage) system which was designed "to cultivate community in a café", and features a display showing content such as photos and quotes uploaded by café patrons and staff. The authors state that the system provides:

"a new channel for awareness, interactions and relationships among people there"

Regarding the system's impact upon "sense of community", McCarthy et al. (2009) observed:

"The CoCollage display offers a semi-public window into a community, revealing some of the interests – and interestingness – of members of the community in a place that serves as its hub"

Another piece of research in the cafe setting was carried out by Churchill et al. (2006). This research involved the design, deployment and evaluation of the eyeCanvas community display in a combined cafe and art gallery in San Francisco. One interesting aspect of this system was that the situated display was a touch screen and the eyeCanvas application enabled patrons to scribble and share messages in the form of "finger scribbles".

Kray et al. (2007) also carried out a situated display deployment in the café domain (in the city of Newcastle in northeast England) which received longitudinal evaluation and revealed sense of community to be supported.

2.4 Situated Displays in Urban Settings

The CityWall system (Peltonen et al. 2008) comprises a multi-touch interactive public display deployed in Helsinki city centre. The large display (measuring 2.5 meters wide) shows user generated photos of the city that have been tagged with "helsinki". Passers-by who chose to interact with the display can perform a variety of gestures to resize, rotate and reposition the photos on the display. The large size of the display means that multiple users can interact with the display and its content at any one time.

3 Hermes Displays: Supporting coordination and community in a Computing Department Setting

3.1 Overview

We have explored the use of situated displays within the Computing Department at Lancaster University in two generations of the Hermes door and photo displays. The first deployment of Hermes (Hermes 1) consisted of ten door displays and a photo display. Owners of the ten displays were split between lecturers, Ph.D. students, research assistants and administrative staff.

In June 2004, the Computing department moved to a new specially built building called InfoLab21. With this relocation we saw the opportunity to build on the results of the Hermes 1 installation with a new, larger, deployment of Hermes displays (Hermes 2). A total of 40 displays were deployed based on new hardware with larger screens. We also included a new photo display with this deployment.

Fig. 1. An early Hermes1 display.

3.2 Hermes 1 Door Display and Photo Display Deployment

This first generation was based on PDAs situated beside office doors. They allowed office occupants to set and display messages and visitors to scribble messages using an attached stylus. This deployment was active between April 2002 and July 2004, a total of 27 months. During this time frame over 5278 owner messages were set and 775 visitor messages were left. Through these we gained a substantial insight into long-term acceptance and usage of semi-public displays along with context sharing behaviours and preferences in this environment. An example of these Hermes door displays installed outside offices in the computing department as shown in Figure 1.

One of the questions we wished to answer with the first deployment of Hermes displays was that of whether traditional methods for sharing personal information and context, e.g. sticking a post-it note on your office door, could be achieved with a digital equivalent. Further to this aim, we wished to explore the new possibilities this digital equivalent would allow to extend these traditional methods into new realms, such as remote interaction and rich media messages.

3.2.1   Supported Functionality

In deciding the functionality to support in the Hermes display systems, a user centred approach was taken whereby functionality was added to the system through consultation with, and exploration of requests made by, the users of the system. Through this, our intention was to develop systems with simple and intuitive functionality easily accessible by a range of users (within the Computing department at Lancaster) with sufficient dependability to enable adoption and use over a longitudinal deployment.

The functionality supported by the Hermes 1 system can be considered from two distinct perspectives, namely: the perspective of the owner of the Hermes 1 display and the perspective of a visitor to the Hermes 1 display. Visitors were able to leave the owner a message by drawing with a stylus on the Hermes 1 display. Based on requests from owners we designed the system such that messages left by visitors did not remain on the screen but disappeared from the display once entered. An owner could read his or her messages left by visitors on a secure web portal. Owners were also able to configure textual messages and image files to appear on their Hermes 1 display using the web-portal. A typical textual message is shown in Figure 2 and illustrates how an owner would often use their display as a means of sharing personal context based on either their current activity (as in this example), location (e.g. if the message had read "Gone to Gym") or time (e.g. if the message had read "Back in 5 minutes"). A full analysis of the ways in which the Hermes system was adopted and used by owners in order to share personal context information in order to support 'awareness' amongst colleagues is presented in (Cheverst et al. 2009).

Fig. 2. A typical textual owner message left on a Hermes 1 display.

Fig. 3. A typical 'scribbled' owner message.

Consultation with owners suggested the need for a feature to enable the owner to create a freehand message by using a touch screen interface on the door display itself. An example of the kind of message that was left on door displays once this feature was implemented is shown in Figure 3.

This feature required the addition of basic owner authentication, which was implemented with a simplified username/PIN system with an on-screen keypad. However, owners found the overhead of authentication too high and so following consultation we introduced a means for enabling a 'temporary' message, such as "Gone for lunch" by tapping twice on their Hermes display. The first tap brings up a set of buttons each one representing one of a set of predefined messages. A second tap is then required to select their chosen message. This technique for setting temporary messages proved very popular for the majority of Hermes owners. Indeed analysis of usage logs revealed that the average number of messages set per day tripled following the introduction of this interaction feature. This highlights an important trade-off between flexibility/control and effort on behalf of the user.

The system also enabled the owner to use SMS or MMS via their mobile phone in order to remotely send a message or picture to their Hermes display. This feature of Hermes proved extremely useful for enabling a door display owner to post their current status, for example, if stuck in bad traffic on the way to work or

otherwise delayed from being at their office (see Cheverst et al. (2003) for more details regarding this aspect of the system and its usage).

One of the most popular features to be added to Hermes (during the later stages of deployment) was one which enabled owners to e-mail messages to their displays. One owner in particular (a member of the senior administrative staff) had a regular habit of e-mailing a department-wide mailing list whenever she was going to be away from the office for more than a few hours. On discussing her requirements, it became evident that adding an e-mail feature to Hermes, allowing these messages to be CC'd to the Hermes system, would greatly reduce the effort required by her to keep her presence information updated on her door display. After implementing this feature the secretary made extensive use of it.

One common type of image that door display owners (in particular lecturers and researchers) posted to their door display was photographs of their latest conference venue. This observation led us to consider whether a larger situated display could prove useful that would support the display of such photos. In particular, we were interested in investigating whether or not by placing such a display in a corridor we would see community usage develop around the display by people with office situated close to the display.

Consequently, we developed and deployed the first Hermes Photo Display in a corridor on the lower floor of the Computing Department building (see Figure 4 below).

The display was in place for a period a several weeks and at the end of this period we spoke informally to those people with offices on the corridor shared with the display. The feedback we received confirmed that the people on the corridor (mostly Ph.D. students but also some lecturers) all felt that the sense of community had strengthened in the corridor given the patterns of use that had developed around the display – namely, people on the corridor sending pictures to the display of places they had visited or humorous content.
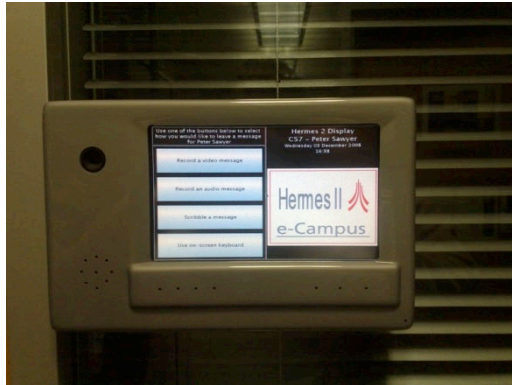

Fig. 4. The first Hermes Photo Display.

Fig. 5. A Hermes 2 display showing both owner message and visitor buttons.

3.3 Hermes 2 Door Display and Photo Display Deployment

Following the dismantling of the original Hermes 1 system in July 2004 and our move to a new department building in Infolab21, we realised an opportunity to create an even more extensive ubiquitous display deployment. This consists of a full deployment of Hermes displays across two corridors and 40 offices. These new Hermes 2 units were designed based on multiple user studies and much consultation. They include cameras, microphones and Bluetooth, as well as the use of a larger seven inch widescreen display. This larger screen was chosen by the majority of door display owners from the original Hermes system during a 'show case' study in which a variety of display options (based on high fidelity prototypes) were presented to previous owners.

The larger screen area has meant that door displays have enough screen real estate to enable the screen to be divided into 'visitor' and 'owner' sections (see Figure 5). In the 'visitor' section, the owner can decide which of a set of messaging options are available to the visitor. For the door display shown in Figure 5, the owner has chosen to have the following four messaging options available to any visitors: "Record a video message", "Record an audio message", "Scribble a message" and "Use on-screen keyboard".

Alternatively, owners can decide to have the entire screen area reserved for their own messages, as shown in Figure 6 below.

Many of the offices in the new Computing Department are multiple occupancy and Hermes 2 door displays now provide support for shared offices. In this case, the GUI of the display is divided into a number or rows with one row per person. For example the display shown below in Figure 7 is used to support a shared office with two occupants.

Fig. 6. A Hermes 2 display showing the owner message only, in this case the owner has chosen not to have his door display support the functionality enabling visitors to leave messages.
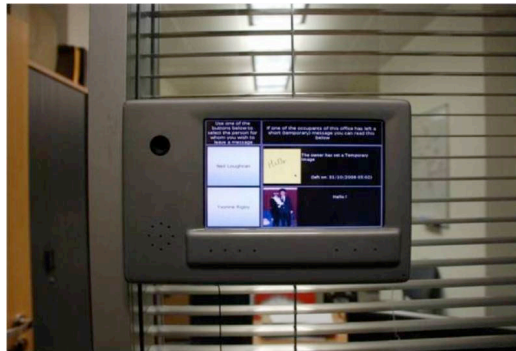

Fig. 7. A Hermes 2 display supporting a shared office with two occupants.

The Photo Display was also deployed in the new InfoLab21 setting. The display itself was mounted using a wooden structure as shown in Figure 8.

The new setting for the display was in a communal area open to a much wider audience than the previous (students, lecturers, administrative staff and research assistants). Consequently, the application was modified to enable any user to submit or download content and to support multi-user interaction. In more detail, a user could use their Bluetooth enabled mobile phone to upload a picture to the display or to select and then download a photo image from the display to his or her mobile phone. The design and implementation of this system posed a number of technical constraints and interaction challenges (see Cheverst et al. (2005) for a comprehensive description), e.g. how to manage the pairing of a specific user's phone with the photo display when multiple users are within Bluetooth range of the display. This particular challenge was solved by displaying (as a set of labelled buttons) the names of Bluetooth phones discovered by the Photo Display and prompting the user to select (by touching the appropriate button) their particular phone.

Fig. 8. A visitor to the Computing Department downloading an image from the Photo Display onto her mobile phone (March 2006).

An exploratory user study provided a number of useful insights into general user acceptability issues, interaction issues and the potential for such a display to facilitate notions of community. The user study involved a mix of 17 undergraduate and master's students and overall the response of students to the display was very positive. The results of this user study are described in detail in Cheverst et al. (2005).

4 Hermes Displays: Supporting intimacy in a Home Setting

The Hermes@Home system is a version of the Hermes system that has been tailored for deployment in the home. The layout of the display is similar to that of the Hermes 2 displays but instead of buttons being shown for leaving a message the 'scribble' message pane is always displayed. The basic idea behind the displays was to support notions of intimacy between family members when one of the members was away from home for extended periods of time. The Hermes@Home unit would act as a display for content, e.g. photos or text messages of the person away from home, while the at-home family members would be able to scribble messages on the units touch screen display in a very lightweight fashion.

A small number of initial 'formative' deployments have taken place and an analysis of use has revealed many similar categories of messages to those encountered with the Hermes deployments (see Saslis-Lagoudakis, et al. (2006) for more details). A typical home deployment is shown below in Figure 9.

It is important to note that the placement of this Hermes@Home unit (as was the case with all deployments) was very carefully chosen by the family members. In more detail, its placement was at a high traffic location that was frequently passed by the various family members.

Fig. 9. A typical Hermes@Home deployment, situated in the home of a lecturer during a six week extended visit to Australia. The display is shown towards the lower centre of the photo.

Fig. 10. Typical Hermes@Home messages left by the at-home family member.

The main pattern of interaction that would occur around the display was one of the family member checking for new pictures or messages from her partner and scribbling 'touches' of intimacy. Examples, of these kinds of messages are shown in figure 10.

It is important to observe how expressive the scribble style of message leaving can be compared to, for example, a text message.

Interviews with the family members who had displays in their homes revealed how even though many of the messages scribbled onto the Hermes@Home display did not appear to contain much information or appear to require much effort to write, there were issues regarding the recipient (the 'away' family member) reading the messages in a timely manner. For example, one family member commented how they would not want to talk to their partner over the phone until they had had read all the messages that they had been left since the last time they had spoken. Another family member commented how: "I think it would be good to see what [messages] the other person has read or not".

The interviews with family members also revealed how the displays appeared to have embedded some form of presence of their partner. For example, one family member commented:

"For me it was a bit like a window to where [anon] is".

And another family member commented:

"When I left, I said goodbye to it as a link to you".

5   Situated Displays: Supporting a Sense of Community in a Rural Setting

Following our positive experiences with the Hermes Photo Display we decided to explore whether situated displays could facilitate and support a sense of community within a rural village setting. Lancaster's computing department had previously worked with members of a village called Wray (a small village not far from the university with a population of about 500) and so we decided to ask one of our contacts within the village (via e-mail in March 2006) whether she and some of her fellow villagers would be interested in being involved in a project utilizing situated displays, to which they agreed.

We utilised a number of methods for understanding the setting in Wray village. These methods included basic ethnographic observations of traditional noticeboards situated around the village (Figure 11a below) and the use of cultural probe packs (Figure 11b below). As part of the instructions for completing the probe packs we asked residents to note places in the village where community content was currently displayed and were it might usefully be displayed in the future.

We also attended community events to gain further insight into the domain and potential users such as the annual scarecrow festival in which members of the village put on public display scarecrows which they had designed and created themselves (Figure 12).
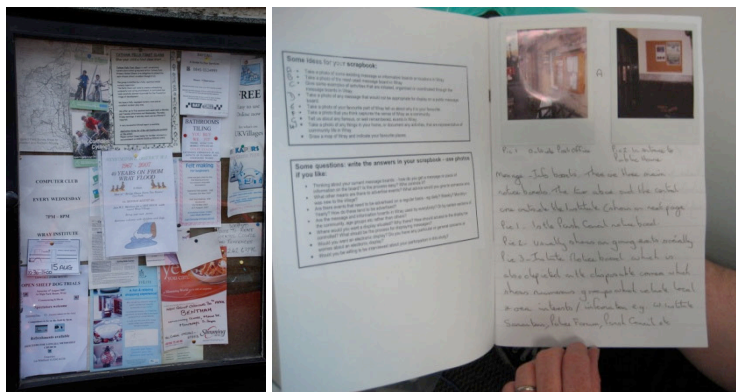

Fig. 11 a) A noticeboard outside the Wray village hall, and, b) part of a completed probe pack.

Fig. 12 Examples of scarecrows on display in the village of Wray during its annual scarecrow festival public event.

Fig. 13 a) A meeting with residents in the village hall, and, b) historic photos of past village life on display in the village pub.

Following the return of the probe packs, a meeting was held in the local village pub (Figure 13a) in which it was decided to deploy a 'technology probe' in the village in the form of a simple digital display that would show pictures of the scarecrows from the annual scarecrow festival (the photos initially being uploaded by the author rather than a member of the village). This display would effectively be a stand-alone version of the Hermes Photo Display and it was agreed that it would be deployed during the summer of 2006 for several weeks in order to gauge initial community acceptance and feedback. Initially, we encountered some difficulties in communicating the concept and potential of the situated display and how the simple display of 'village pictures' could help foster a sense of community within the village. However, fortunately on display within the pub were a collection of historic photos of past village life (Figure 13b) and, when these were highlighted to villagers at the meeting, the point regarding community was successfully made.

The photo display was also in place for a village 'produce show' event which took place towards the end of the summer and during this event the technology probe received significant usage and many comments were left by users. Figure 14 below shows the display being used by one of the village's elderly residents who was unable to identify herself in one of the pictures and is writing in the comments book a suggestion for the pictures to be made bigger to enable her to view them more clearly.
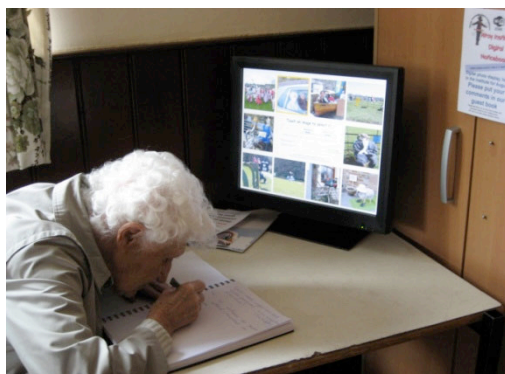
Fig. 14 The technology probe being used by an elderly resident in the village hall.

Following the produce show, the technology probe was refined using the requests for additional functionality (received either via e-mail or the comments book placed next to the display). The most significant change to functionality was support for additional categories of photos (i.e. in addition to the scarecrows category). However, supporting this additional functionality posed the question of whether or not to force some kind of moderation process in order to ensure the appropriateness of any and all new content that would be uploaded to the additional categories. Another meeting was held with villagers to discuss this issue and it was decided to support additional categories through the use of multiple moderators. In more detail, when a request was made for a new category of pictures, e.g. historic photos, then the villager making the request would be required to agree to moderate content for that particular category. This way it was envisaged that control of the system would be much more in the hands of the villagers as opposed to academics at the university.

The display remained in place for over three years, during which time various alterations have been made in response to feedback from residents and our own observations of the display in use. Many of these were minor alterations, including the ability to post comments on photos and to send digital 'postcards' by email, which were popular features suggested by community members themselves. However, the most substantial change came after feedback repeatedly suggested that residents would like to be able to post advertisements and news for local events and businesses.

After deciding to continue development of the display in this direction, a number of meetings were held to determine how this functionality would best be provided. Two events which had occurred in the village on the day of one meeting were particularly helpful in relating our discussion to real events: firstly, residents had missed a consultation about a proposed wind farm because the news had been posted a month earlier and forgotten, and secondly, a suspected scam artist had visited the village and persuaded an elderly resident to spend £1000 on frozen fish. Discussion around these events helped to identify a need for breaking news and increased prominence for notices as they became more salient.

Fig. 15 a) The WrayDisplay prototype in the post office, and, b) The WrayDisplay prototype in the cafe.

We also aimed to explore how much screen space for photos users were willing to sacrifice in exchange for news content. Although participants were extremely uncomfortable when asked to sketch user interfaces themselves, we subsequently found that pre-prepared paper mock-ups were useful for stimulating discussion around the user interface. Surprisingly, residents at the meeting supported a far greater emphasis on news than we had expected, stating that much of the photo content displayed was now several years old. Based on this feedback, WrayDisplay was deployed into the post office on a larger screen featuring both photographs and notices (Figure 15a). The improved architecture of this new display also enabled the deployment of a second display into a small cafe/bistro in the village (Figure 15b), with content shared across both displays.

The displays have now been operational in the village for a considerable period of time and further detail on usage and issues that have risen from the deployments can be found in Taylor et al. (2007) and Taylor and Cheverst (2009).

6   Discussion

From the case studies we have observed that situated displays do indeed have significant potential to support notions of community. However, as discussed in Cheverst et al. 2008:

> "in addition to the difficulty of successfully designing and implementing systems, the evaluation of their 'success', i.e. their ability to foster and support a sense of community, is also a challenging problem".

Our approach is to use a combination of quantitative and qualitative evaluation methods. The quantitative techniques analyzed usage logs while the qualitative techniques included: observation, informal feedback, interviews, questionnaires, focus groups, etc. Typically, we would use quantitative measures of use to inform qualitative evaluation, for example, to identify anomalies for further investigation and to validate qualitative findings. The data from these techniques has enabled us

to continually collect and explore new/changing requirements in a timely manner during longitudinal deployment.

Additionally, evaluation has to 'fit in' with the users and the deployment (i.e. focus group/design workshop every week would not have been an option). The development team was then able to consider requirements on a range of levels (technical challenge, anticipated usage impact, novelty, alignment with aims of the work, etc.) and select features to explore through mote focussed design session involving users. Also, we do not underestimate the effect on users of taking their suggestions and feedback seriously and it has been important to communicate our commitment to them in this regard.

One crucial factor when designing situated displays to support community is that appropriate interaction methods should be in place to enable any user to create or alter content on their display (in other words, the system should consider the accessibility requirements of its entire user group). In the case of the Hermes Photo Display, situated in a communal area in the computing department of Lancaster University, we found that enabling users to upload content via his or her Bluetooth phone was a perfectly suitable method. However, despite some initial signs of enthusiasm from members of the Wray 'Computer Club', we found that Bluetooth was not a popular method for submitting content with the Wray Photo Display. Consequently, we introduced a website for allowing a greater cross section of the community to upload content and we are currently considering further approaches (e.g. the use of flatbed scanners) in order to further open up opportunities for posting content to the display by those members of the community who currently struggle with the website.

Another crucial factor for designers to consider is whether content moderation is required for the uploading of content and how this should be achieved in a scalable manner which ensures the community being served is in control. With the Hermes Photo Display the fact that users were required to register their phone's Bluetooth address acted as sufficient deterrent to prevent inappropriate content from being uploaded. However, with the Wray deployment it was necessary to implement explicit moderation processes in order to maintain the trust of the community.

7 Concluding Remarks

In this chapter, we have presented our exploration of the design, deployment and use of Situated Displays for supporting notions of collaboration (Hermes 1 and 2), intimacy (Hermes@Home) and community (Wray Photo Display). More specifically, we have described our work with three settings, the first that of a university campus, the second a home environment, and thirdly, a rural village in the north on England. Central to our approach is obtaining a strong understanding of the settings and the importance of actual deployments for understanding issues that can

only arise through actual use in a real world setting and not through short-term experiments or 'toy' installations.

Our approach to evaluation is typically driven by the need to continually gather qualitative information from users both quickly and effectively in order to react to new and emerging requirements as swiftly as is feasible. As described throughout this chapter, we found this necessary in order encourage and support adoption during longitudinal prototype deployments. Crucially, in order to support coordination and community in our deployments it was necessary to weave feedback and participation from the community into a changing and evolving technological design.

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