Publics in Practice:
Ubiquitous Computing at a Shelter for Homeless Mothers

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ABSTRACT
Today, commodity technologies like mobile phones—once symbols of status and wealth—have become deeply woven into social and economic participation in Western society. Despite the pervasiveness of these technologies, there remain groups who may not have extensive access to them but who are nonetheless deeply affected by their presence in everyday life. In light of this, we designed, built, and deployed a ubiquitous computing system for one such over-looked group: the staff and residents at a shelter for homeless mothers. Our system connects mobile phones, a shared display, and a Web application to help staff and residents stay connected. We report on the adoption and use of this system over the course of a 30 week deployment, discussing the substantial impact our system had on shelter life and the broader implications for such socio-technical systems that sit at the juncture of social action and organizational coordination.

Author Keywords
Constructed Publics, Homeless, Urban Computing, Longitudinal Study, Qualitative Methods

ACM Classification Keywords
H.5.3 Group and Organization Interface: Collaborative Computing, Evaluation/methodology

General Terms
Design, Human Factors

INTRODUCTION
The presence of digital technologies in contemporary Western life is ubiquitous. Mobile phones, computers, data networks and the shared computational resources that come with them have created new opportunities for sharing [12, 29], for connecting individuals and groups in novel and meaningful ways [4, 5], and for extending participation through the democratization of information and the mobili-

zation of civic action in a number of different civic and community based contexts [10, 26].

Despite the broad scope of human endeavor that has been positively impacted by the maturation of the field of computing, there remain, even within the riches of Western society, groups of people left out of the rapid advance of and opportunity provided by the "digital age." Being left behind is often due to a lack of economic capacity, inadequacies in education and training, and a mixture of institutional legacies that create barriers to access and participation and which serve to reinforce social marginalization. [1].

Within the United States, the urban homeless are an example of a social group that may not have extensive access to digital technologies but is nonetheless deeply affected by the pervasiveness of such technologies in everyday life. In everything from maintaining social connections to friends and family, to online registration and verification for social services, to finding and applying for employment and housing, the presence and necessity of interacting with technology has real consequences—and opportunity—for the urban homeless [21, 30, 35].

Despite the daily impact of technology on the urban homeless, few services and applications have been developed to specifically address their needs [27, 28]. Instead, typical efforts have attempted to broach the problem as one of technology access; unfortunately, such efforts are often unsuccessful because they fail to contextualize access in ways that translate into lasting technology adoption [19]. As a compounding factor, technologies deployed to the homeless need to account for the social and institutional infrastructure upon which the homeless depend [23]; purpose built systems for the homeless need to include points of interaction for the many service providers who provide care, manage resources, and act within a regulated environment [23].

The work we present here sits within this context: we have designed, built, and deployed an information system for the staff and homeless residents at an emergency night shelter. The system we designed and deployed uses elements from ubiquitous computing [34]: text and voice messaging links residents' mobile phones to a shared display in the shelter and to a collaborative desktop Web application for shelter

staff. These components afford new channels of communication between the shelter staff and residents.

During the design of the system, we framed our approach as designing for two *publics*—the shelter staff as one public and the residents as the second [22]. We return to that framing here as an analytic lens to understand how the system was adopted and the role it played for the staff and residents during a 30 week deployment at the shelter. In doing so, we can begin to unpack the impact of the system on staff work practices, on identity and action of the residents, and on the social boundaries and interactions between the staff and residents. Ultimately, we found that the ubiquitous technologies we selected provided a means for the two publics to express and develop new attachments to each other as they confronted the issues affecting their lives.

BACKGROUND & SYSTEM DESIGN

We have previously detailed the fieldwork and design process used in developing our system [22, 21, 20, 23]; however, we will provide a brief overview of the system goals and key features in order to support the analysis of system use being presented here. The system—called the Community Resource Messenger (CRM)—was conceived as an intervention to let shelter staff send messages to residents about available services, reminders about appointments, and amplify their ability to help the individuals with whom they were working. The CRM was also designed to let residents make inquiries of their case manager, and to share and preserve their accumulated knowledge and experience on coping with homelessness. To address these issues, we designed and developed the CRM through a participatory process that focused on providing both staff and residents tools to support the individual and shared issues each faced.

Publics as Design Framing

To address the challenges of working with two distinct, but interwoven groups of stakeholders, we framed our design approach as one that would support and bridge two distinct but interrelated *publics*: the public of the urban homeless and the public of the staff at a specific shelter [22]. We built upon recent work within HCI [9, 8], Participatory Design [11], and Science and Technology Studies [24] that builds on John Dewey's definition of publics. For Dewey, an American pragmatist philosopher, a public is not a generic mass of people, but rather a dynamic group of stakeholders that take shape as people move to mitigate or promote particular social consequences [7]. An important part of Dewey's notion of publics is the idea that publics are both *plural* and *particular*: multiple publics exist, each constituted in response to particular shared social conditions.

Marres has further contributed to the notion of publics by arguing that the dependencies and commitments—or *attachments*—people have are critical to constituting membership in a public [24]. In particular, Marres points out that by focusing on the attachments of a public, we gain a better vantage from which to ascertain the issues around which a public forms. In particular, this foregrounding of issues enables us to move away from aligning with *a priori* groups of stakeholders, which are "usually characterized as relatively stable entities [with] established ideas, values, symbols or institutional devices" [24], and instead allows us to examine the fluid exchange of membership in a public as attachments to issues that are articulated and acted upon.

For Ehn, in considering how publics might inform participatory design, it is the articulation of issues that takes primacy as it enables a participatory design intervention to move beyond configuring materials or technology for *present* use, and instead to focus on configurations—social and material—that will facilitate *future* use [11]. This design-for-future-use—or what Ehn calls *infrastructuring* (borrowing from Star [32])—bolsters the notion of publics by arguing that participatory design can be used to *constitute* and *sustain* a public through the articulation of relationships to shared issues.

In the case of our context, the early participatory design set the groundwork for constituting and supporting the staff and residents at the shelter as two publics [22]. By so doing, we were able to foreground the *dynamic relationship* each had to a range of issues. For the shelter staff, these issues included sharing information, and coordinating care activities across different care providers—both internal staff and external agencies. For the residents, it meant understanding the social support networks and institutions upon which they depend. It also meant recognizing that while the public of the staff was stable, the public of the shelter residents was not; residents would come and go, and would not necessarily identify as part of a "homeless" public, eschewing the stigma of homelessness and more readily self-identifying as individuals overcoming adversity.

From this point of view, several specific design areas came to the fore: for the shelter staff it meant focusing on ways to help cope with resource constraints [20, 23], manage multiple relationships [16], and provide support for cooperative action as staff worked together to support several residents at a time [20, 23]; the areas of focus for the shelter residents included features to mitigate information overload [14, 21], enable continuity in maintaining social support and trusted relationships [15, 16, 21], and finally the introduction of features to address the transient and impermanent nature of membership in, and knowledge of, their public [6, 31]. We drew on these areas, derived from our understanding of previous literature as well as our own months-long fieldwork at this and other care providers, to focus our participatory design activities with the shelter staff and residents.

Participatory Design Engagement

The design process we employed engaged shelter staff and residents, both individually and together. In broad strokes, our design work was broken into three main activities. First, we held a day-long design workshop with the staff from several area service providers. This workshop was focused on identifying the goals, resources, and information flows at and between a group of service providers with whom we were working. The activities at the design workshop were largely used to understand the larger service provider ecosystem and how specific services dovetailed with each other (and where gaps were in that integration) [22, 23].

Figure 1: CRM system architecture.

The second part of our design process focused on the extended staff at the shelter where we would eventually deploy the CRM. Beginning in 2009, we met regularly with the staff. Over the ensuing months, design activities moved from initial fieldwork to understand the work practices at the shelter to defining specific CRM features. We then used progressively higher fidelity prototypes to communicate design ideas, gather feedback, and enable staff to evaluate and re-design features to better suit the way they worked.

Third and finally, we worked with the shelter residents to define the kinds of features that would support their information needs. We iterated system features and worked with the residents to engender transparency in the design process, giving them a voice in how their information would be shared with and between the staff. This was an instance of where we intentionally sought out opportunities to recognize and engage with the established power relations at the shelter: the default position of both staff and residents was that the staff knew what the residents needed and were best equipped to share that information; however, through the course of the design work and then continuing into the system deployment, residents came to a realization that their ideas were useful and helpful for each other and that they could rely on each other for information and advice [22]. To support this kind of resident-to-resident knowledge sharing—and preserve that knowledge over time—we developed features that enabled residents to act as *producers* of information rather than presuming they would only be *consumers* of information provided by the staff.

Functional Overview of the CRM
The resulting ubiquitous computing system comprised three user-facing components (see Figure 1): shelter staff accessed the system through a web interface called the Mes-

sage Center, shelter residents accessed the CRM via mobile phones, and information awareness for both shelter staff and residents was provided via a shared display called the Shared Message Board. Each of these components was meant to address three different foci of activity: staff needed a central place to manage their messaging activity as well as share messages with each other to keep abreast of specific residents' needs and progress; the residents needed access to staff for help and information while away from the shelter; and staff and residents needed a way to share information with each other while co-located at the shelter.

For shelter staff, the Message Center was used to send messages directly to residents, to post information to the Shared Message Board, and to share information among the staff. Messages to residents could be addressed to multiple residents at once (similar to addressing an email to several recipients). Additionally, messages to residents could be scheduled for future and/or recurring delivery (*e.g.*, for specific future events or standing reminders about shelter meetings or other regular activities). Message sharing occurred by enabling staff to view each other's messages.

For shelter residents, access to the CRM was accomplished through basic mobile phones. In order to keep the barriers to interaction as low as possible, residents only had to send text (SMS) messages or leave voicemail at one of two phone numbers: a *private* phone number for routing messages to shelter staff and a *public* phone number for routing messages to staff and residents via the Shared Message Board. SMS messages were forwarded directly to the CRM while voicemail messages were first transcribed to text using Google Voice before being forwarded on to the system.

When co-located at the shelter, staff and residents had access to the Shared Message Board; a 24″ monitor mounted prominently near the shelter entrance, driven by a small desktop computer. The display cycled through three different information views: messages from staff originating from the Message Center, messages from residents originating from SMS and voice messages sent to the public CRM number, and external information gathered by scraping results from a housing search website.

An offsite server hosted the CRM functionality and provided telephony integration functions. All messages were stored in a MySQL database accessed through JDBC. The Message Center and Shared Message Board software components were deployed as Java web applications on Apache Tomcat along with supporting Javascript for presentation, interaction, and dynamic browser updates. Private and public SMS messages were routed using Kannel, an open source GSM gateway, and Google Voice respectively. Google Voice was also used for speech-to-text transcription of voice messages left at the public phone number.

SYSTEM DEPLOYMENT & METHODOLOGY
In February of 2010 we deployed the CRM to an emergency night shelter for single mothers and their children. The shelter allowed each family to stay for 30 days. Time beyond 30 days (up to a firm maximum of 90 days) was typically granted only under specific circumstances, such as

when extra time was needed to accommodate a job transition or to allow for some flexibility for those placed on waiting lists for transitional housing programs. Additionally, the shelter was only open at night: residents had to leave by 8 AM and could only return after 4 PM, so a significant part of their day was spent away from the shelter and hence away from the staff and other sources of information.

Our deployment was built around a systematic program of semiweekly meetings with shelter staff and residents to study how the CRM was being adopted. We held two one-on-one meetings with the shelter staff each week to discuss their perspectives on the CRM. The shelter staff involved with the CRM included three women: the program director, a weekend case manager, and a night manager. The program director ran the daily case management activities and had a very hands-on, face-to-face style of working with the residents. The case manager worked with the residents during the weekends when the program director was not present. The night manager was only present in the evenings and was there primarily as an emergency contact—she had no formal case management responsibilities. We ran our meetings with the staff as open-ended interviews and discussed current system use, issues they were having with the CRM, or improvements they wanted made.

For the residents, the study experience had three main components. Starting at intake, after explaining the study and obtaining informed consent, we gathered basic demographic data about each resident, including age, education, race, and data on ownership and use of mobile phones and personal computers (including questions about specific applications, *e.g.*, SMS on the mobile phone and chat, email, and social networking sites on the PC). To ensure participating residents could use the CRM if they chose, we provided mobile phones (a Nokia E50) along with $50 worth of pre-paid credit to residents who did not have their own phone. Residents who had their own mobile phones were reimbursed for expenses incurred from interacting with the system; no other form of compensation was provided.

The second component of the study for the residents was the semiweekly meetings held with the researcher. Meetings alternated between one-on-one interviews and focus group sessions. During these interactions, we would discuss how the CRM was being used, the specific features that the residents had found useful or irrelevant, and how its use was changing from week to week. Extensive field notes were taken during these meetings, notes that were in turn used to inform subsequent interviews and focus groups.

The third and final component of the study was a one-on-one interview that occurred as each resident left the shelter. This final interview was more reflective about how they used the CRM while at the shelter, the nature of the interactions they had with shelter staff and with fellow residents via the system, and a discussion of any specific events or opportunities that arose via their use of the system.

The final source of data for this study came from observational fieldwork we engaged in during our semiweekly trips to the shelter. Each week, we took time to observe shelter life and note how staff and residents went about their routines. These observations served to inform the questions we would ask of either staff or residents, and helped us contextualize their responses.

These data—the demographic survey data, notes from one-on-one and focus group meetings with the staff and residents, the exit interview data, the field notes from our ongoing site observations, along with detailed system logs and usage reports—provided the raw materials we used to analyze CRM use and integration at the shelter. Field notes and interview data were analyzed in a rolling data analysis that allowed the lead researcher to explore specific developments among the staff and residents during the interviews and focus groups [25, 33]. System usage data was used to help provide additional context around how the system was used and to triangulate our qualitative analysis with rhythms of life at the shelter across several generations of shelter residents.

FINDINGS

The use and adoption of the CRM must be understood given the constraints of the shelter it was deployed to: the women who came to the shelter were in a period of crisis, generally in a disoriented emotional state while also experiencing difficulty in practical matters. During their initial 30 days at the shelter, they would need to find work (or better paying work), establish childcare or enroll their children in school, and they would need to secure long(er) term housing arrangements. All of these tasks were done with ample help and guidance from the shelter staff, however, direct contact time had been limited to evenings, making in-the-moment assistance nearly impossible to coordinate.

Characteristics of Shelter Residents

In total, 25 residents at the shelter participated in our study. All of the residents were female, and all but one self-identified as African American (the lone exception identifying as Hispanic). The average age of the residents was 33 years old with a maximum age of 53 and a minimum age of 20. Education level across the residents was normally distributed: four (16%) had completed some high school, 12 (48%) had high school diplomas, six (24%) completed some college, and three (12%) had a two- or four-year college degree. On average, residents stayed at the shelter for 35 days, and groups of residents would typically arrive and depart at regular intervals—what we refer to as "generations" of residents.

Mobile phone ownership was common with 19 (76%) of the residents having their own mobile phone. Of those who owned their own phone, 12 of the 19 (63%) had monthly contracts; the remaining seven (37%) used pre-paid mobile phone plans. Regardless of mobile phone ownership while at the shelter, the majority of the women used SMS messaging—22 (88%) reporting they used it regularly for staying it touch with friends and family, with self-reported message volume ranging from tens (10+) to hundreds (100+) of messages per month. Personal computer ownership was low with only five (20%) of the residents reporting owning a computer; however, all of the residents used computers at
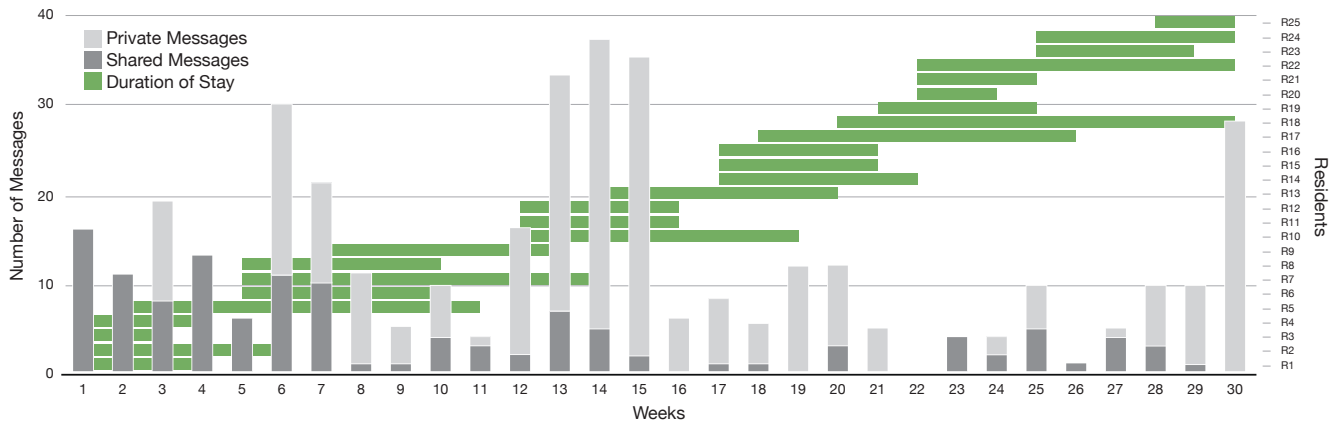
Figure 2: Weekly message volume, broken down by private/shared messages and illustrated against residents' length of stay.

least once a week through organized classes at the shelter, and the majority of the women, 18 (72%), reported using computers three or more times a week at locations like the public library, local charities, or at work. Computer use was described as including email and web at a minimum, with nearly half of the residents—12 (48%)—also reporting the use of social networking sites (*e.g.*, Facebook).

These characteristics begin to paint a picture of the technology practices of the women who came through the shelter. They were familiar with mobile phones and with using SMS—often preferring SMS as a way to keep in touch with friends and family during the day. They also understood things like Facebook and the kind of mediated interaction that takes place through online channels. These familiarities helped the residents understand the CRM and the different modes of communication it afforded, enabling us to use similes for posting messages to the Shared Message Board as like posting on a Facebook Wall.

Patterns of Use

By looking at the system usage data, we can begin to see how use of the CRM coincided with the rhythms of shelter life. Figure 2 provides detail on system use by overlaying two visualizations: the first depicts length of stay at the shelter via the horizontal bars—each bar represents a shelter resident (R1–R25 from bottom to top), the position and length of the bar indicates the week of arrival through the week of departure; the second graph is a vertically stacked bar graph (in two-tone grey) indicating the weekly total of messages sent to individuals (*i.e.*, private messages in light grey) and the weekly total of messages sent to the Shared Message Board (*i.e.*, shared messages in dark grey) by both staff and residents. By layering the data this way, we can see how the generations of residents (weeks 1–4, weeks 4–10, weeks 10–16, weeks 16–21, weeks 21–25, and weeks 25–30) coincide with message volume cycles over the 30 week deployment.

The graph in Figure 2 illustrates the processional nature of CRM use—from the messy and erratic use during initial weeks of the deployment, through to a settled pattern as staff and residents appropriated the system in support of the activities at the shelter. The irregular message volume dur-

ing the first eight weeks of deployment came primarily as the staff began populating the Shared Message Board with information that had previously existed elsewhere in the shelter: phone numbers and addresses for ancillary programs, details about shelter procedure, external agencies serving specific needs, along with inspirational messages. After this initial setup work was done, the staff settled into a routine of updating the Shared Message Board as new information became available—a routine that resulted in a few messages per week.

By week 6, the staff and residents had begun to send a larger volume of private messages via the CRM—a trend that continued through week 30. The shift toward a higher volume of personal messages tracks the arrival and departure of generations of shelter residents. When a group of new residents would arrive, private message volume was low (Figure 2: weeks 4, 11, 17, 22, and 26), but would then increase and peak as individuals in that generation of residents became ready to move on (Figure 2: weeks 6, 15, 20, 25, and 30). This cycle was in part the result of residents moving from personal crisis to stability and in part the result of the case management style of the staff who would progressively give the residents more responsibility.

While this pattern generally held during our deployment, there were distinct characteristics of use within each generation of shelter residents. In particular, weeks 13–15 had a large volume of messages that did not reoccur until the very end of the deployment in week 30. To better understand what was different between the weeks of high and low message volume, we carried out a content analysis of the messages sent through the CRM. Two researchers coded each message according to one of 13 categories—topics covering specific resources like childcare, housing and employment, as well as topics like "case work" that covered coordination messages and "relationship work" that covered messages meant to establish trust and rapport. Inter-rater reliability ($\kappa=0.8984$ with $\sigma=0.0178$) indicated a robust categorization rubric for the content exchanged via the CRM. Based on our content analysis, further details about message origin, and our qualitative experience with the lives of the women at the shelter, we are able to attribute these peaks in use to

the unique way the particular residents at the shelter during weeks 13–15 and again in week 30 bonded with the staff.

Throughout the deployment, the staff accounted for 55% of the private messages (residents 45%); however, the standard deviation was quite high at ±25%; so from week to week, there was considerable variability in participation between staff and residents. During the weeks with a high-volume of messages, the split in participation between the staff and residents remained at 55%-45%, but the standard deviation dropped significantly to ±11%, indicating a much more even participation. Moreover, based on our content analysis, it was clear, throughout the deployment, that staff and residents used the CRM for coordination around specific service procedures (*e.g.*, securing long-term housing, following up on employment, or managing childcare), but during the high-use weeks in question, there were more messages that indicated a personal connection between the staff and residents (*e.g.*, "*I really enjoyed the meeting yesterday evening. Perhaps we should have more bonding and sharing experiences*", and "*Thank you, I look forward to talking to you too*"). This is important because it ties increased instrumental use of the CRM—using it to secure the services and resources necessary to move out of the shelter—with the experience of managing those resources *vis-à-vis* the relationship between staff and resident.

Overall, the cycle of use that developed with the CRM is validation that the design was appropriate, useful, and usable for the staff and residents at the shelter. Yet, it also points to two important developments with respect to how the CRM supported the two publics of shelter staff and shelter residents and how technology use can be leveraged within the broader homeless community. First, given our initial design framing of supporting two distinct publics, the CRM needed to do two things: it needed to support the articulation of common issues, some evidence of which is apparent in the content of the messages passed through the system; and it needed to support coordinated action around those articulated common issues. The staff and residents engaged in that common action when they used the CRM to share information about services and to accomplish microcoordination to secure necessary services. It is important to point out that the action that was being taken through the CRM was new action never before possible—72% of the private messages exchanged via the CRM occurred during the day when staff had been previously unavailable to the residents—so it is not just that the CRM supported existing practices, but that it was instrumental in developing new practices.

The second point touches more generally on technology use by the homeless. As we pointed out above, the mothers at the shelter were familiar with using SMS, however, they used it almost exclusively for maintaining social relationships. This kind of social use is an important part of what digital technologies provide the homeless—a means of coping with stigma and maintaining some level of social inclusion [21, 30, 35]. However, translating non-instrumental use of technology into instrumental use has remained a challenge in no small part because the conceptual leap from viewing technology as *abstractly* useful to internalizing the *concrete* ways it can help is often difficult as the incentives remain indirect (*i.e.*, it is not always clear how mastering Word will help individuals find work) [19, 27, 28]. However, with the CRM, the incentive to interact with the system was inherently *social* as it was based on the relationship between the staff and the residents. The outcome of that social use, however, was *instrumental* in that it connected the residents to the services and help they needed to move out of the shelter and on with their lives. In short, no conceptual leap was necessary for understanding *how* the CRM could make a difference for the shelter residents.

Experiential Data

While the system usage data and content analysis help us understand what parts of the CRM were used, providing evidence of action taken via the system, the qualitative data from the semiweekly interviews and focus groups with staff and residents, along with the ethnographic observation done at the shelter, give us empirical evidence about how and to what extent system use impacted existing shelter routines. To understand this impact, we return to the notion of publics as an analytic lens for examining how the CRM affected shelter norms, how relationships between and among staff and residents were affected, and how information sharing enlisted different forms of membership in the public of shelter staff and the public of shelter resident.

Redrawing Social Boundaries

The first point we consider is the way the CRM impacted the relationship between the staff and the residents at the shelter. In particular, the adoption of the CRM for diverse communication needs initiated a redrawing of some of the boundaries between these two publics.

During weeks 10–16, conflict within the shelter began to develop around the completion of required chores. Prior to the deployment of the CRM, such conflicts were handled with face-to-face confrontations between the staff and the residents. By week 10, however, the staff had begun to rely on the ability to send messages directly to the residents in place of some of that face-to-face interaction. During a particular episode when chores—such as cleaning up after meals—were not being completed, the case worker used the CRM to send a message to several residents, writing, "*I am not sure whose turn it is but I have knocked on your door to remind you that the chore assigned to your room was not completed. Please take this opportunity to determine who needs to sweep and mop the kitchen. Thank you M—*"

This particular message marked a shift toward managing confrontation via the CRM. It also expressed a nascent tension between the case manager and program director. This tension was rooted in different notions of how to manage relationships with the residents. In particular, the program director felt that using the CRM to enforce shelter rules was not enough, and that the mothers needed to be confronted immediately when they broke those rules.

During an interview after this exchange occurred, the case manager defended her actions, asserting that sending the residents a message gave them the opportunity to correct

their actions without being compelled through confrontation. In the case manager's words, "*it returned power*" to the residents, allowing them to choose how and when they would respond to the message, an example of which is provided below. This point is important on two counts. First, it highlights the tensions that arose from introducing new technologies into the shelter, and how those tensions express the dynamic way publics can reconfigure around particular issues—in this case the way shelter rules are expressed and enforced. Second, it shows how a new form of staff-resident communication was instrumental in establishing a new social boundary that reduced intrusion for the shelter residents.

The redrawing of these social boundaries was facilitated not just by the ability to message someone while they were not present, but, as the case manager noted, by the fact that "*the system [provides] a record that a message was sent*." This record created a perceived verification that a particular message was received, displacing the need for face-to-face communication to ensure accountability by the residents. As a result, the redrawing of social boundaries within the shelter was a combination of newfound mobile and asynchronous communication capacity, along with a concomitant capability to maintain the accountabilities previously exercised through direct interaction via message persistence.

This freedom impacted the staff and residents differently. The staff could send a message to residents about a particular issue and feel they had appropriately transferred responsibility to the mother in question; the residents could choose how and when to respond to a message, thus asserting themselves without confrontation and engendering a capacity to establish boundaries according to their needs and not just according to the rules of the shelter. It is in this regard that the CRM supported the staff and residents as two distinct publics, allowing each group to respond to issues independently.

Sharing Information for Action and Identity
The next element of the CRM we consider is the Shared Message Board—a large screen mounted in the entry to the shelter (see Figure 3)—and its role in supporting the public of the shelter residents. The initial goals of the Shared Message Board were to provide a visible place for both publics—staff and residents—to share information. As the deployment unfolded, we found that the message board became more than just a place to share information, instead becoming a mechanism for surfacing common issues and establishing shared identity.

For the staff, the Shared Message Board was initially seen as a means for providing basic information to the residents consistent with the cork and whiteboards already present in the shelter. However, the impact of the Shared Message Board became apparent in a particular incident during the run-up to the Easter holiday. In the weeks before the holiday, a paper flier about a free family outing had been posted on one of the existing cork boards. While the flier was on the cork board, none of the residents asked to sign up for the event. The week before the event, however, the case

Figure 3: Shared message board and a shelter resident.

manager posted the same information on the Shared Message Board, noting in a subsequent interview that, "*as soon as it went up on the [Shared Message Board], two mothers were interested and signed up [to attend]."* She and the program director were genuinely excited about this development because it was a clear instance where information on the Shared Message Board was more actively engaged by the residents than other forms of shared information (like the existing cork boards) had ever been. One of the reasons for this was that the animated display created an expectation that new information would appear on the screen, so the residents were naturally drawn to it as a source for daily updates.

Further evidence of how the Shared Message Board impacted the residents came when the program director watched a current resident demonstrate how it worked to a new resident. The fact that senior residents were spontaneously educating new arrivals encouraged the program director that the technology was becoming an important part of the residents' routines. This in turn led the program director to request additional features for managing information on the Shared Message Board—a request that the case manager pointed out as indicative of how well the CRM had been received at the shelter, especially given the program director's initial skepticism: "*[the fact that] Ms. [program director] wants more information up is a testament to its success*."

The Shared Message Board also supported the expression of issues among the residents and became a medium for taking action on those issues. In a message posted to the Shared Message Board during the incident when residents were not completing their chores, one resident said, "*We came to [the shelter], it was a blessing for us all and we knew the rules right away… We agreed to do them but we're not doing [them]. This is the right thing and count our blessings and …keep it clean…*"

The prominence of the Shared Message Board in the shelter made it a focal point for the public of the shelter residents. This was seen through the way residents responded to messages posted to the Shared Message Board, it was seen in how residents took it upon themselves to induct new residents into the routines of use surrounding the Shared Message Board, and it was seen through instances of self-organization that were mediated by the Shared Message

Board. In particular, posting a message reminding fellow residents of their commitments was an act of articulating and organizing action around a particular issue. But more than just managing shelter chores, we would point to this incident as one where the women at the shelter identified themselves as a cohesive group—a public—confronting common issues. It might seem mundane to organize around chores, however, for the women at the shelter, all from very different backgrounds, thrown together for a brief and tumultuous period, establishing shared identify and supporting each other was an important event. The role of the CRM in constituting this nascent and transient public came by providing a platform that helped the residents express and self-organize around these common issues.

Destabilizing a Stable Public

Finally, we turn to the ways in which the CRM impacted the work practices and responsibilities of the staff and how it altered different roles within the shelter. By adopting this system, the staff had implicitly agreed to new forms of work: they would need to update messages on the Shared Message Board and develop routines for checking messages sent to them by residents. Both of these tasks would need to be done in a timely manner and would need to be integrated into existing case management activities.

The most significant change that came with the introduction of the CRM was that the division of labor was refactored, placing most of the responsibility for updating information on the case manager. As a result, as use of the CRM became more established, it shifted the balance of power: by virtue of using the CRM to message residents and post information to the Shared Message Board, the case manager's role at the shelter was amplified. The consequence of this was that dormant ideological differences between the program director and the case manager were amplified as well.

These tensions were exposed as a result of a very specific design decision about how information would be shared among staff at the shelter. During the participatory design phase, the staff made a significant change to how the Message Center worked; instead of treating each staff login as private, the decision was made to treat the CRM like a forum where staff could see all messages [22]. The rationale was that it would help the staff better coordinate action during the handoffs from week to weekend care by enabling better contextual awareness of what was going on with each of the residents.

While this was true in use—the staff did have better awareness of ongoing communication—that awareness was limited and imperfect. The brief nature of messages sent to mobile phones (typically adhering to the 160 character limit of a single SMS message) meant that the larger conversation, one that often started during a face-to-face meeting, was difficult to ascertain. Furthermore, the forum-like qualities of the CRM became an invitation for the program director to surveil the activities of the case manager. In one specific instance, the program director reproached the case manager for contacting a former resident with what had been mistakenly interpreted as an invitation to an event for current residents. The result of this exchange was that the case manager temporarily stopped using the CRM, a fact reflected in the message volume of week 22 (see Figure 2).

More fundamental, however, was the way this interaction affected how both the case manager and the program director framed their roles within the shelter—and as such, their roles as members of the staff public. There were two factors that affected this reframing. The first was that the CRM provided the case manager an effective tool to extend her contact with the residents. By being able to message them more easily, she was able to keep in touch during the week and maintain better continuity with the mothers at the shelter. As she put it during an interview, "*I see part of my job as building rapport with the mothers*." However, by using the CRM to extend her relationship with the mothers, she initiated the second factor, which was that the case manager's heavy use of the system raised her visibility to the residents and changed some of the established power dynamics at the shelter. Prior to the CRM deployment, the program director had the most contact time with the residents and established a strict relationship with them. She enforced the rules and often made difficult decisions on how to distribute limited resources. Meanwhile, the case manager acted as a confidant and advocate for the residents, a weekend-only foil to the "tough love" provided by the program director. As the case manager began extending her relationship via the CRM, the center of influence shifted, amplifying the nurturing role of the case manager.

At its core, the issue here centers on how using the CRM redistributed power and influence along different notions of how to establish effective relationships with the residents at the shelter. While the public of the shelter staff was something we presumed as stable during the design phase [22], the CRM created an environment where the prior attachments to shared issues became altered, in this case initiating a renegotiation between the case manager and program director on how to build and maintain appropriate relationships with the residents. Yet despite these tensions, both the program director and case manager remained enthusiastic about the role CRM had in sharing information with each other and with the residents.

DISCUSSION

When we set out to design the CRM with the staff and residents of the shelter, we had an explicit goal of catalyzing and supporting two unique but interconnected publics [22]. Drawing on Dewey's notion of a public—defined as a dynamic organization of individuals formed by the desire or need to address an issue [7]—we sought to create an interactive system that would support the efforts of staff and residents in the shelter by providing a platform for exposing and articulating issues so that shared action could be taken.

A critical part of this effort to design for two publics was to design the system so that it would sustain each public over time and not just be an artifact of the specific conditions under which it was designed. Our level of success in achieving this is evidenced through the sustained system

use over multiple generations of shelter residents—residents who had no part in the initial system design.

This success, however, took different forms. Whether through facilitating a redrawing of boundaries between staff and residents, or by being enlisted in the construction of shared identity, or in waking dormant tensions among the staff, use of the CRM was shaped by the social dynamics at the shelter. The role the CRM played in the shelter was expressed differently for the staff, for the residents, and for the interaction between the two, but in all cases was shaped by the social context of the shelter—the staff and residents chose to use the CRM in particular ways, and those choices had subsequent consequences on shelter life.

In particular, the destabilization and subsequent renegotiation of roles that arose among the staff is consistent with Dewey's notion of publics as mutable entities. Furthermore, it reinforces why using publics as a rubric for designing the CRM was important: publics are meant to be dynamic, and changes in the makeup and characteristics of a public should come naturally as attachments to particular issues change over time. By building for this kind of dynamism, we created a system that encoded the capability to express particular issues rather than one that encoded particular established power dynamics.

This capability to express and respond to different issues did not come from a specific desire to disrupt power dynamics at the shelter. On the contrary, it arose from a commitment on our part, as system co-designers, to provide appropriable tools to the staff and residents so that they could resolve issues as each saw fit. As use of the system developed, new strategies for confronting common issues also developed, and in the case of the staff, that use disrupted established power dynamics. The subtle point here is that the tension experienced by the staff was not one of staff versus staff or of staff versus technology, but one of evolving attachments to the issues of how to manage relationships within the shelter as facilitated by the CRM.

This kind of exploration of attachments has parallels with systems like UrbanSim or Water Wars that focus on making explicit the commitments of various stakeholders [2, 17]. However, unlike those systems, the CRM enabled immediate action to be taken on the issues expressed via the system. The staff and residents work separately or together to resolve the issues they face. The action precipitated by CRM use was specific to the homeless care community where technologies are more often deployed as procedural resources for enabling oversight and accountability [3, 18, 23]. The support provided by the CRM, however, came by way of amplifying the relationships among the staff and residents rather than by attempting to bypass those relationships with a rationalized system for managing constrained resources. We would argue that one of the reasons the residents in particular did not view the CRM as a burden was because their experience with the system was social rather than procedural: it facilitated their relationships with staff and it provided a way to further establish and share in their relationships with each other. The result of supporting the staff and residents by way of their relationships was that the CRM became a socio-technical resource for the shelter; a stable medium for sharing information that helped the staff be more effective and helped the residents feel more connected, while providing the degrees of freedom necessary to foster and sustain a number of unique relationships within the shelter.

Despite the the degrees of freedom provided by the CRM, the overarching relationship between staff was bounded by the larger context of homeless care provision. The fact that the system was situated in an emergency shelter for women displaced by homelessness meant the intrinsic need the residents had for help and guidance—the "placefullness" of the shelter [13]—ultimately shaped how the CRM was used to communicate and organize. While both staff and residents incorporated the CRM into their practices and routines the basic relationship of staff as producers and residents as consumers of information was not overtly reconfigured. In fact, the primary challenge left unaddressed by the CRM centers on how to better enlist the shelter residents as producers of information, as the source for knowledge about resources and services, rather than just as collaborative consumers. While we observed instances of production by the residents, it was not a consistent pattern of use and is something we are looking to further explore in a revised design of the CRM.

Given our experiences with the CRM, we feel there is a significant role for mobile technology in addressing the homeless, and underserved communities more generally. As we have demonstrated here through the deployment of our system, such technologies can open new lines of communication between the homeless and their care providers, leading to more efficient and frequent communications, better coordination, and improved awareness of resources and needs. The CRM is an example of a ubiquitous computing system that achieved these outcomes by empowering users to identify and respond to the social issues facing them rather than by encoding specific solutions to those issues. In addition, we also sought to further the exploration of Deweyan publics as a rubric for understanding and evaluating participatory systems. The relevance of publics for building and studying systems like the CRM is the foregrounding of issues experienced and actions taken by users without encoding particular perspectives or solutions to those issues in the technology itself; that the technology is not the solution but rather a means for users to articulate their attachments to an ever evolving set of issues.

ACKNOWLEDGEMENTS

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