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# Exploring Wearable Ambient Displays For Social Awareness

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**Abstract**

Mobile phones represent not only a means of communication, but an increasingly omnipresent computing platform, enabling diverse modes of communication including ambient displays that are tied to bodies and social groups, rather than physical environments. As an example of such a display, we present Damage, a prototype device for mobile ambient awareness of a social group, and discuss design considerations for such devices.

**Keywords**

Social computing, ambient display, wearable, tangible interfaces, mobile phones, group communication

**ACM Classification Keywords**

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

**Introduction**

Mobile devices are an accessible and increasingly ubiquitous computational tool. Potential as a computing device notwithstanding, users still view the mobile phone as a phone; its primary appeal is not computing power but the ability to engage in both remote and collocated communication. It is the computational power of the mobile phone, however, that enables

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multiple modes of communication, allowing it to go beyond the one-to-one voice communication of the traditional telephone. The use of text messaging [5] and mobile push-to-talk [13] have been explored by HCI researchers, and it has been noted that constant availability and constant awareness are becoming commonplace. How, then, can we leverage the computational power of the mobile phone to allow people to communicate and connect in innovative, peaceful, emotionally satisfying ways?

We first examine related research in mobile group communication and present Slam, a mobile group messaging system for the Smartphone. Driven by issues raised by this investigation as well as user feedback on Slam, we designed Damage, a wearable ambient display of group activity. Early user feedback on Damage highlighted a diverse and highly situated set of mobile communication needs. We then discuss design considerations for mobile ambient awareness devices.

### Mobile Group Communication

Devices for mobile communication are becoming increasingly ubiquitous, with the number of mobile subscriptions per capita estimated at 84% in the UK, 92% in Italy, and 106% in Taiwan in 2002, pinpointing that year as the pivotal moment at which mobile phone use exceeded that of land line phones [15]. Research in use of SMS among young people reveal patterns of lightweight continuous contact [5, 7] as well as sharing of messages amongst collocated friends [11]. Mobile push-to-talk, having noticeably different interactional characteristics from phone service, has also been observed to maintain long-term remote presence [13]. The cell phone hardware itself can be a site for enacting

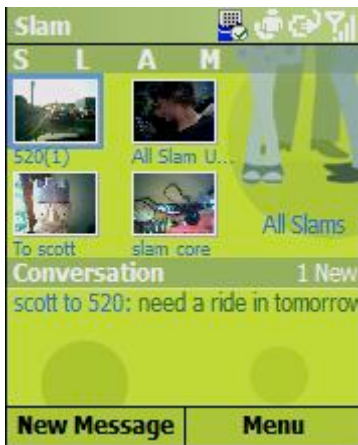
one's identity, signifying stylistic preferences or membership in a subculture [7].

One of the most compelling reasons stated for buying and using cell phones was to coordinate a family's complex schedule [2]. This coordination tends to be cobbled together using currently available pairwise communication capabilities of the mobile phone, but recent research indicates that group communication might add to these practices. By "group communication" we refer not to a collection of one-to-one communications amongst a group of friends, but rather a form of one-to-many or many-to-many communication by and for all members of a group. Farnham et al [4] note that close-knit local social groups depend heavily on group communication in the form of email lists in order to coordinate activities. While one-to-one communication is, of course, an important part of their social lives, group-wide communication makes coordination for face-to-face interaction much more tractable.

#### *Slam*

Slam is a group messaging application for the SmartPhone running Windows Mobile. It provides a user interface for lightweight formation of and navigation between groups. For each group, messages are archived and displayed on the phone in reverse chronological order, providing a clear view of a group's conversation. Text messages are sent to the entire group. Photos can easily be included in a Slam message and are integrated into the display of messages in recipients' phones.

Feedback from participants in a 10-day-long study of Slam use indicated that they liked the feeling of being



**Figure 1:** Slam main screen

“always on”, and felt significantly more connected to their social group. An average of 3.98 messages were sent per day, including simple and repeated “good night” messages, which replicates previous findings in studies of SMS use [5, 7]. However, some users regarded the constant vibration of their phone throughout the day, often at work, as a nuisance.

## **Damage**

### *Design*

We approached the design of Damage (so named because it provides tangible evidence of Slamming) with the goal of creating a wearable ambient connection to a social group. Because the display was to be a semi-public piece of jewelry, we aimed for flexible interpretability, allowing groups of users to socially assign meaning to the display in ways that would not necessarily be evident to strangers.

After several iterations, the design we arrived at was similar to a studded bracelet. Each bracelet contains six studs, five representing individuals, and one representing whole-group activity. This number seemed appropriate due to prior research into SMS use indicating that people typically communicated regularly and frequently with 4-7 friends [5]. Each individual stud contains four LEDs in red, blue, green, and white. A pulsing white LED on one of these studs indicates that a Slam message is waiting from that person. The colored LEDs glow steadily and their meanings are determinable by members of the group.

Previous projects in social communication [8, 9, 10] indicate that people readily develop meaningful codes, give minimal but flexible and interpretable means of communication. Red, blue and green messages can be

sent from the bracelet by opening and closing three metal snaps. The sender of the message can send another signal to turn the LEDs off, otherwise they will fade out after half an hour. The group stud contains one white LED that glows incrementally brighter as messages are sent amongst the group, with the glow diminishing over time if no messages are sent. If the group is larger than five people, then messages sent by individuals not mapped onto individual studs will still affect the group stud. The group stud is visually and tactilely distinguishable from the individual studs.

### *A Usage Scenario*

Alice routinely engages in both group and individual messaging in Slam with a group of seven of her friends. She most frequently corresponds with her three roommates (Carol, Louis and Hattie) and a couple of close friends (Kat and Bunny); these five friends are usually displayed on her Damage bracelet, though when she was at a conference recently she switched out her roommates for her three classmates with whom she was attending. Alice, Kat and Bunny have long ago agreed on a few basic codes; when Alice gets out of class at 3:30, she closes a snap on Damage to light her friends’ bracelets blue. At 3:50 she notices Kat’s stud on her own bracelet is also lit up in blue, and moments later it starts pulsing white. She checks Slam, and there is a message from Kat to the whole group asking if they want to meet at the coffee shop. Alice sends another message to the group: “I’m down. I’ll light up red when I get there.” On her way, Bunny’s stud lights up red and Alice finds her waiting when she arrives. Alice sets her bracelet again to let Kat know that both friends are meeting her. After a few minutes, Bunny, impatient, opens and closes a snap on her bracelet, causing her stud on her friends’ bracelets to flash red



Figure 2: Damage design sketch

on and off. Kat responds by briefly flashing red, reassuring the two that she is aware of them; she arrives at the coffeeshop a few minutes later, apologetic for her lateness. During coffee, Alice notices Louis's stud light up green, which they have agreed means he has arrived at home.

#### *Implementation*

The SmartPhone on which Slam runs is Bluetooth enabled. A Promi-ESD-02 Bluetooth chip was used to enable Damage to communicate with the phone. A PIC16F877A microcontroller communicated with the Bluetooth chip over UART, sending and receiving short messages to and from the phone. Messages specify the color of the LED, which stud to activate, and whether to turn the light on or off. The PIC parses the message it receives and controls the pulsing, on/off status, and fade-out time of the LEDs on the bracelet accordingly. On button presses, a message is sent back to the phone specifying color and on/off. The message is sent to other group members' phones via Slam, and the mapping of individual contacts to bracelet studs is managed on the recipient's Smartphone, also in the

Slam application. The prototype bracelet consisted of two layers of leather sewn together with circuitry sandwiched between. The studs were 5/8" in diameter and molded of polyurethane with four LEDs embedded in each. The "buttons" were metal snaps on leather tabs that could be snapped in place or unsnapped to signal friends' bracelets to blink on or off.

#### *Early Feedback*

Two focus groups were conducted, one comprised of three men and two women between the ages of 20 and 30, the other of 4 men and 3 women between the ages of 16 and 19, all frequent users of cell phones and SMS to coordinate social activity. Slam was described and demonstrated to them, as well as the idea of small accessories that can communicate with the phone. Participants were given pencils, paper, crayons and modeling clay, and asked to design devices for group communication. Amongst focus group participants, designs involving bracelets and watches were popular, though a few suggested necklace displays that would be more visible to others than to the user. There was some desire to display photos of family members. The ability to receive alerts were important to participants with children, as well as younger participants who lived with their parents.

Participants were next shown a physical prototype of Damage and asked for feedback. The younger set was generally more positive, with some requests for more variety in physical styles. Almost all participants wanted greater flexibility, some requesting multiple group studs, some stating that they only wanted to keep track of a significant other, and many indicating that they wanted more flexibility in tracking individuals from multiple social groups. Members of the younger group

expressed concerns that a wearable social display might get them in trouble in class (something we'd been designing to avoid) and suggested a design that included a watch, giving them a legitimate reason to look down at their wrist, with subtler indicator lights surrounding the watch face.

### **Design Considerations for Wearable Ambient Communication**

Brewer [1], in proposing design considerations for site-specific ambient displays, describes "sites" to include "an abstract situation (e.g. a group of friends)". This resonates with our own findings, and we contend that such a display of social activity must be well-situated in the social practices of the person and group that uses it. In the course of designing and prototyping Damage, several considerations emerged as particularly important for our design.

#### *Quiet Technology*

Our goal in creating Damage is to provide a non-interrupting visual indicator of Slam activity, fostering a sense of connection without constant distraction, and enabling a smooth transition to active messaging when desired. Conveying information in a peripheral, non-distracting way is a design consideration for any ambient display, but also a particular concern for mobile and wearable devices. Worn by the user in many different physical and social settings, a wearable communication device has the potential to distract not only the user, but also anyone nearby (a phenomenon that we know only too well from our experience with cell phones). Quiet peripheral display, then, can be particularly valuable for wearable devices, as noted by [6].

#### *Negotiated Interpretations*

In his work with intimate objects [8] Jofish Kaye explores the amount of interpretation that can be applied to the simplest possible communication – a single bit – depending on the context of the communicating couples and their current situations. Buddy Beads' [9] semi-secretive means of sending coded communications (by tapping beads) informed our design. Damage was designed to engage users in a very open-ended interaction, in which the meanings of the minimal light display could be negotiated amongst users. Weilenman's ethnomethodological work studying ski instructors' use of a minimal mobile awareness device [12] indicates that, with interactionally flexible communication devices, norms of use develop through face to face interaction *about* the systems as well as mobile interaction *through* the system. Mobile users may switch back and forth between these modes of interaction, sometimes encountering situations in which rich communication is not possible. The context that renders these displays interpretable may tend to be almost entirely social and negotiated, since physical settings are apt to be unpredictable.

#### *Semi-public display*

Feedback from focus groups indicated that our users were quite savvy to the semi-public nature of a wrist-worn display, even mentioning the inclusion of a watch face to provide social camouflage for their use of Damage. The general visibility of a wearable display has implications for how the information is displayed, and dovetails with our considerations around "negotiated interpretations". Social negotiation may render an ambient wearable device meaningful to a group of friends, but conversely strangers may find it unintelligible or regard it as purely aesthetic.

### *Tangibility and Intimacy*

A critical component of Damage and other wearable communicative interfaces is their physicality; they are tangible tokens of social connection. They could quite easily have been conceived as mere displays of sensor data or location, but instead physical action must be taken to communicate. Certainly there are reasons for this that are related to personal privacy and the wish to avoid surveillance, but we contend that there is another purpose to the physical input. Designed for groups of close friends, these devices seek to reproduce certain aspects of the intimacy these groups manifest when co-present, an intimacy that is often physically expressed through touch and proximity.

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