

Probing the Potential of Non-Verbal Group Communication

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ABSTRACT

Designing for non-verbal communication using e.g. gestures and other bodily expressions is difficult. Hardware and software need to be co-designed and harmonize in order to not throw users out of their embodied experience. We aim to design for kinaesthetic expressions of emotion in communication between friends – in this case, colleagues at work. A probe was built using sensor node technology designed to let users express themselves and their emotional state to a public and shared display where the expressions together formed a collective art piece expressing the individuals but also the group as a whole. Two groups of colleagues used the probe during two weeks. It came to serve as a channel in which some conflicts and expressions of social relations were acted out which were not openly discussed in the office. It exposed different roles and balances in relationships in the group. Finally, the probe taught us the importance of balancing the design for joint group expression and individual, personal expressions. The study also allowed the participants to experience the sensor node-‘material’ – enabling a participatory design process.

Categories and Subject Descriptors

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

General Terms

Design

Keywords

Richer expressiveness, friends at work, technology probe, autobiographical design.

1. INTRODUCTION

A subfield of Human-Computer Interaction (HCI) has focused on designing for supporting awareness of remote presence or activity in the workplace [5, 12] and in the home [3, 21]. Most of these systems aim to increase efficiency of work tasks or to manage family activities, but recently there has been a shift from more information oriented systems to keep track of co-workers or family members, to those that try to embody a general sense of presence of others to provide comfort, a sense of togetherness or

strengthening the ties between people [20]. Aspects of those ties are, in some systems, designed to be expressed in terms of kinaesthetic, gestural expressions. There are several systems that are designed for romantic couples [7, 27], individual reflections on your own physical, emotional status [25], and enhanced emotional expressivity in person-to-person communication [23, 26]. But there has been little focus on kinaesthetic expressions of emotion and closeness in communication within groups of users, in particular for colleagues at work.

The boom of sensor-technologies offers new materials that can potentially be used to create for embodied, physical presence of others. Some sensor-technologies are spread in the environment, as in sensor networks, and some we strap onto our bodies for sports- and health applications. These sensor technologies allow for gestural interaction [2, 24], picking up on bodily, emotional signs and signals [18, 26] and together with actuators, such as haptics or interactive plush toys [17] they create for a new exciting design arena. We can use all these new interaction opportunities to capture and build upon more of what the richness of body language and gestures entails. However, it is not trivial to design for what Isbister and Höök name supple experiences [13]. In short, a supple system is a hardware device that uses custom-built hardware, sensors, and wireless communication, to interact with end users and create a physical, emotional, and highly involving interaction. Supple systems rely on subtle signals; rich human communication and interpretation strategies such as emotion, social ritual, nonverbal communication, and kinaesthetic engagement; and emergent dynamics, to provide for a moment-to-moment experience. To create a supple system, hardware and software need to be co-designed [28] and made to perfectly harmonize in order to not throw users out of their embodied experience [26].

It is in the intersection between the issue of designing for kinaesthetic expression of emotion in communication in sociable relations and co-designing hardware/software taking its material qualities into consideration that our work can be placed. We are aiming to design for non-verbal communication in groups of colleagues or groups of friends, making use of the new materials offered by, in particular, sensor-technologies. Each individual would be equipped with a tangible, sensor-enabled device, possibly integrated with their mobile phone or with their wrist watch. The device would allow them to express themselves and communicate with the group and its members using gestures. Our idea is that their expression would not be a one-way communication from one individual to another, but instead creating a joint expression by two or more users together. Our idea is that this joint expression would portray both individual moods but also interrelationships, between individuals in the group, and in general, allow for playful creation of expressions.

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Inspired by autobiographical design [22], we used a technology probe [9] to let both ourselves and potential other users live the experience of non-verbal communication within a group. By this, we started to uncover some of the sensitivities, practices and fragilities in how groups express themselves, or rather, how we *do relationships*. Creating expressions together using the probe we provided, to some extent, created joint moods, served to act out conflicts, reinforced closeness between colleagues and uncovered imbalances and issues between them. The probe became an arena for some of the efforts that we do in order to create for relationships. Most importantly, it gave us the design input we need to take the next step in the design process.

2. EXPOSING EXPERIENCES

Given the development of games, everyday use of technology as part of our lives, mobile technology, and ubiquitous technology, in the third wave of HCI [9] user experience has been put at core. Desired qualities include designing for aesthetic experiences [15], affect [18], emotional experiences [16], fun [1], affective loop experiences [11, 27, 28], or embodiment [4].

However, we cannot design for such qualities in void – first we need to understand how they interact with the requirements of the specific design case. In this case, we needed to understand what goes on in people’s daily social, emotional and bodily interactions with people they spend time together with. This entails digging into deeply personal, subjective, physical experiences that are hard to express. On top of that, new materials, such as the sensor technologies we used here, may enable new ways of mediating communication between friends. We needed to become emphatically involved with our users’ lived experience of interacting physically with such an imagined system [11, 28].

There is a small, but growing, body of methods for aiming to capture non-symbolic experiences without forcing users to reduce their experiences to their constituent parts, such as cultural probes [6], autobiographical design [22] or the Sensual Evaluation Instrument [14]. Sengers and colleagues reintroduced the idea of autobiographical design, that is, designers designing for themselves and their own needs rather than someone else’s [23]. They thereby circumvent the problem of trying to understand others and their physical, emotional and social experiences. We decided to pick up on some ideas from autobiographical design and expose ourselves and others to a technical probe.

3. BEING CLOSE

Our starting point was from our previous research where we had identified some design qualities that are important when designing for communication and reflection between friends [26]. In short summary, we already knew:

- Friendships require a careful ‘rhythm’ of communication to be kept alive – we have to be there for one-another and keep the bond alive
- Using gestures in interaction is very sensitive to users’ personality, body language and the way the technology is designed – the smallest mistake in e.g. timing between physical expression and response from the system will throw users out of their embodied experience and they will withdraw from the overall experience

- Crude mappings of users’ gestures to expressions in some one-to-one-manner to e.g. emotions will fail to cater for the subtle, dynamic nature of their communication. In-stead, we have to design open surfaces where users can inscribe meaning themselves. But these surfaces should not be completely empty to start with – they have to feel familiar to our bodily experiences of communicating

We have also performed a study of very long term friendships (not yet published). Important findings from this work were:

- A group of friends is not a set of pair-relationships of equal strengths, but a complex organism with many different roles, changing over time – it needs to be ‘managed’ to survive. A group has many relations and constitutes a unity
- Conflicts may be a threat to the nature of friendship, but they are also an essential part of it. When they occur, they test the strength and quality of the relationship and changes it
- A system designed for friends need to include collaborative, strengthening activities (compare to e.g. choir singing, which need the whole group to make sense) that everyone enjoys and where everyone has a role, and allow for richer expressiveness by involving also bodily and subtle communication cues to compose a unity

All these findings points to the necessity of seeing friendship as something we do, rather than something that is simply there and can be expressed in a system. Friendships in groups prosper when we create together, when the whole group is needed, something we come back to below. While colleagues at work are not always friends, there are some similarities between the relationships we build at work and our friendships (and, as we know, work mates sometimes do become friends).

4. THE PROBE

A technology probe is a fairly simple but fully working technical system designed to uncover and learn from real life practices and experiences [9]. The idea is to place the system with potential users to be used in their everyday environment in order to get outside the laboratory and away from some of the obstacles of a staged set-up. It is a way to get initiated user feedback early in a design process.

A probe needs to be partly unfinished but still detailed enough that it provides for rich experiences in the direction of a certain area for design. If a probe looks too beautiful and finished, it becomes hard for study participants to brainstorm about alternative looks and feels. It is more difficult to think of alternative designs if you like the one design you have been using for a while and got used to. The aim is to let users feel competent as designers and to minimize feelings of insufficiency in front of a research team.

A probe is a mean to expose/uncover qualities that otherwise might be neglected. That is why a probe might well include provocations and clearly unwanted functionalities in order to force users, as well as designers, to reflect on their own practice and creatively invent new ways of interacting.

A technical probe is not an early prototype of a future system. It is a way to open up and to get hands on experience of a future design field and new design materials. It is after a technical probe experience that brainstorming sessions on specific design solutions take place. It is a fruitful but rather time consuming method to spur new ideas, since also a technical probe needs little of a design process to evoke rich enough experiences.

4.1 The FriendSense Probe

FriendSense was the technical probe we created to find out more about the relationships and activities that constitutes a group of work colleagues or friends at work. This probe works as follows: each user is given a sensor node (from Freie Universität, Berlin) that picks up on temperature and vibration, see Figure 1. The visual expression consists of a sphere-shaped object resembling a marble or soap bubble. Users first create their expression locally on their own PC and then upload it to a public and shared display where a collective expression of all users' expressions is formed. The shared display was placed so that all users could see it from their desk when sitting in an open office landscape, but also visible to non-users passing by.

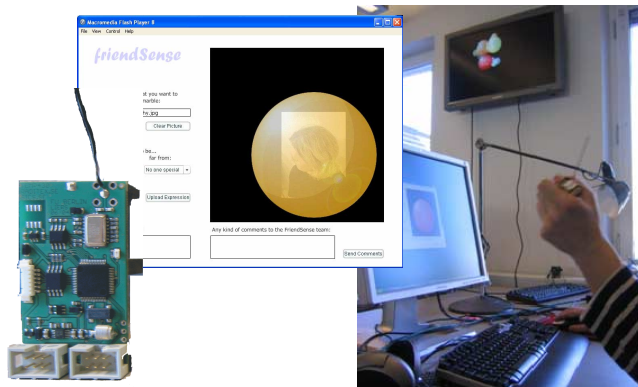


Figure 1. The probe: sensor node, software client, interaction with the sensor node, and an expression on the public display

The motion of the marble on the screen is determined by the vibration sensor, and its color is determined by the temperature sensor. To change the movement of the marble the vibration sensor must be set off through bouncing the node package against some other surface, for example the other hand or the surface of users' desk. The color of the marble is changed by heating or cooling the temperature sensor. The movement and color of the marble were chosen to in a very rough form resemble the bodily experience of manipulating the sensor node. Our intention was also that the possible colors and movements would be varied and expressive enough for users to express their experiences – their mood, emotion, or some other experience relevant to their friends to see. It turned out that the nodes were individually sensitive to stimuli (i.e. each node responded differently to temperature and vibration) and the changes in colors in the graphical representations were continuous. This, in combination with the possibility to also add a picture to be placed inside their marble, made each expression close to unique, and allowed the users to express themselves and, potentially, distinguish the identity of each expression on the public display, see Figure 1. Our design was deliberately ambiguous, allowing for appropriation and interpretation.

As discussed above, we knew that friendships are on-going processes where conflicts sometimes arise. In our first trials of the FriendSense probe, we had seen that it mattered to users exactly where their marble ended up on the big display, or rather, who's marbles were close to one-another. We therefore redesigned the probe so that users could try to affect the positioning on the public display. The exact placement of the marble was a combination of what all users wanted. Depending on individuals' choices and the number of times they were uploaded, an algorithm in the system managed the positioning and relations of the marbles on the screen, a functionality illustrating the 'silent negotiation' going on in social contexts. Since the probe set-up, with a stationary public display in the open office space, forced people to use the probe while co-located, this functionality holds the potential of making this usually silent negotiation not so silent. Here it could be visible to everyone that someone is not wanted or perhaps that someone is wanted more than the others, a consciously designed probe functionality there to provoke and expose and spur delicate experiences. One would probably not want to put this much focus on such sensitive matters if this was not a probe but instead designed to be an early prototype of a future system.

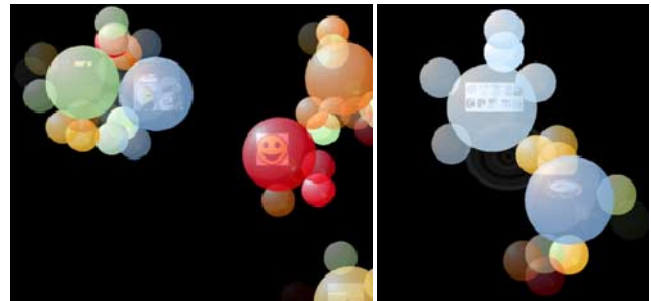


Figure 2. (details) Preceding expressions transform to smaller spheres on the edge on the latest uploads, "history bubbles".

Once a user puts a marble on the joint display, it was left there until the next time the user uploaded a new expression. The old marble would then be turned into a small sphere sitting on the edge of the marble, see Figure 2. These smaller spheres thereby represent the history of expressions used. These history cues fade over time, allowing the users to see the latest uploaded expression as originating in a process. The uploaded expressions were, in this sense, holding more information than just the latest (individual) upload and contributed to the composition created by the group as a whole over time.

5. LIVED EXPERIENCES

The technology probe was deployed in our own workgroup at the Mobile Life centre (that all the authors belonged to) and in a workgroup at TeliaSonera (that none of the authors belonged to). The selection of these two groups was deliberate; being inspired by autobiographical design we wanted to get personal experience enabling an empathic understanding of the other user group and the design area as such but we also wanted the fresh ideas and feedback from another user group as in a more traditional user study. This combination of our own group and an external group, where we had limited prior insights to their emotional and social relations, made it possible to collect a rich material and capture some of the non-verbal communication within a group of friends at work. Below we use fictional names for the participants in the two groups.

5.1 Set-up and collected data

The two groups used the probe system at their respective work places for two weeks each. They were introduced to the intentions of the probe – that is, to enable discussions about emotions, relations, self-expressions, interpretation, and affective experiences taking place in a group of individuals. We asked them to use the system in parallel with their regular work, as much or little they wanted. We provided them with documentation material in forms of diary books and disposable cameras. They could also send us comments directly through the Friend-Sense software, or email us.

After the two weeks of use we performed semi-structured individual interviews that took about one hour each. In those interviews, we asked the participants to reflect on the usage of the probe, on their relations in the group as well as on other group relations that they had experienced. We discussed the collected data together with the user showing them their own comments, number of interactions, and screen shots of the joint screen from different points in time. We asked the users to share their reflections on how the (both individual and composite) expressions had emerged and how they had interpreted them, and finally, whether they had been affected by them. The quotes in the material below originates both from comments during usage and from these interviews.

5.2 Participants

The TeliaSonera group of six users sit closely together in an open office space, but they are almost never there at the same time; they have assignments in external projects, travel, and spend a lot of time in their lab space which is located on a separate floor in the office building. As some are recently employed, and others have been there for two years, their sense of the group differs. They see each other as workmates who sometimes take a beer after work, but not really as close friends.

The Mobile Life group consists of nine researchers who also share an open work space. Some of them have worked together for many years, but the group also has new members. They are most often not at the office at the same time; they work irregular hours and have assignments also outside the lab office. However, during the two weeks of this particular user study, the group spent quite a lot of time together. This group regards themselves as friends.

6. EXPERIENCING THE PROBE

Below, our findings are presented as stories. In particular, we emphasise situations that illustrate four important themes in the data; individual expressive needs; effects on the mood or activities of the whole group by the public display; using expressions to deliberately influence the whole work group, and finally, various examples of group collaboration and co-creation on the public display. The stories also describe how the users physically handled the nodes and their experiences of the material as such.

6.1 Usage in the TeliaSonera group

The TeliaSonera group seemed to be more of a traditional work group. The social norms within the group did not seem to allow for expressive emotional outbursts. For example, they did not want to disturb the others by making too much noise banging the sensor nodes, or to negatively influence the group by showing their own bad mood overtly on the joint screen. In this group,

users picked a picture to place in their marble that acted as their alias or avatar. They often chose a character which they liked or felt empathic with. Erica, for example, picked a picture of a lonely penguin, which she wanted to be placed in the cluster of expressions:

Erica: *“I took my penguin because I like it and also it is actually a picture called ‘alone’, so it is a little lonely penguin and I thought he could get to join this.”*

Allan, who was new to the group, used a picture of Ralph, his favourite character from the Simpsons (the TV-series show). He wanted to show the others who he was through this choice. Unfortunately, most members of the group did not figure out who was who of the marbles during the two weeks. They also said that they cared more for their own expressions than trying to figure out the others’. Allan was the only one who actually knew that, for example, Erica ‘was’ the penguin.

The group used the social positioning feature to express actual physical relation in the room or who they currently were project partners with. They rarely used it to express social or emotional relations to the others. Since they all mapped closeness between marbles on the screen to physical placement in the room, they frequently became annoyed with the fact that marbles stayed on the public display even when people were not there. In the Probe design, we had incorrectly assumed that users would turn off their computer or the probe system by the end of the day or when leaving the office for a longer period in time. This was not always the case which made the marbles linger on the screen.

The users expressed problems with the ‘bulkiess’ of the sensor nodes. They felt that it was easier to use them to express aggressive and negative emotions and had problems to express softer and more gentle emotions, since the interaction provided, especially the vibration sensor, was not affording what they wanted to express.

6.2 A few days in the TeliaSonera group

Erica is annoyed. Anger is an emotion she feels that she easily can express with the sensor node. She puts her marble ‘far away from everyone’, so that she will not disturb anyone else with her anger. She feels that it is improper to “unload” negative emotions on the others. She then hurries to a meeting and her angry, lonely marble is left on the public display in a corner.

When Allan arrives, he manipulates the distance to the others on the screen, trying to make the public display mirror the physical workplace as much as he can. This day he places himself far from John who he knows is sitting somewhere else today.

Later Erica comes back from her meeting and sees that her marble is separated from the others. She sees her penguin inside the marble is someone else, not “herself”, and feels empathic with the penguin, wanting to cheer it up. She tries to create a cheerful expression and places it among the others on the public display. In doing so, she finds it hard to manipulate the sensor node in a way that feels cheerful. The limited range of manipulation offered by the sensor node forces her to perform similar gestures as if she had been angry (the expression she is trying to achieve is red and jumping), and that evokes annoyance and, ironically, angry feelings. The result of her interaction, the expression on the public display, the noise, and the sensation in the hand are also almost identical to anger. After a while she gives up, disappointed that she could not get the expression she wanted.

Another day Marcus comes to the office in a terrible mood (because he hates commuting) and he is, actually, looking forward to being unpleasant to the others and to share his negative mood, but gets very disappointed when he realizes that the office space is empty. When he looks at the shared display, it looks like they are all there, though. As a matter of fact, Carl has had the same expression for several days. Marcus is not entirely sure of who is who on the public display; he only perceives “a bunch of bubbles”. He picks the same picture as yesterday (a picture which he has chosen because it has graphical qualities making it looking good inside the marble) and chooses to be ‘close to Carl’, this to see where he ends up. Carl and him are involved in the same project and will work together later that day and they also physically sit closest to each other, so Marcus thinks that should be shown also on the public display. During the day, when his mood changes to be more sociable: “OK, now I am on it again!”, he also felt it was important to change the colour to something warmer, make the marble appear more active (i.e. vibrate), and move away from the corner on the display, towards the centre, reflecting the change in mood.

Present when absent. Even though this group mapped physical presence and proximity with the marbles on the public display, and, in fact, often got confused when the virtual did not agree with the physical, they sometimes used the probe to get a sense of connectedness, when away.

Erica: “[I] sit in another room [today] and usually sit close to Maria. I’ll put my marble close to her, so that I feel a little bit like “home” anyway, in a sense”. See Figure 3.

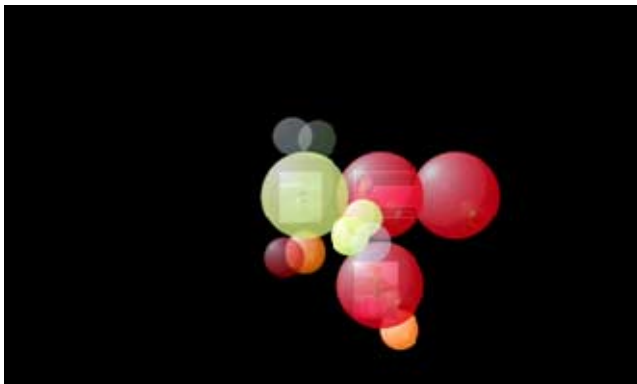


Figure 3. Erica (upper left) feels she is in safe arms by placing her marble close to the others (Maria is lowest), while she is away at a meeting.

Reflections on the group through the probe. When up-loading their individual expressions they most often wanted to express their individual mood and position the marbles in line with actual, physical positions in the real world. This group rarely purposely used the public display as an arena for acting out interpersonal or (social or emotional) group relations. However, sometimes, they were happily surprised by the results on the screen, and translated it into real world interaction: the closeness and movements of the marbles changed the perception of the group in the real world:

Maria (looking at the public display): “Wow! We are really close, really cosy, we are even touching each other, we really are a whole group here. [laugh] ‘Oops, what happened here?’, sort of”

Work friends vs. close friends. The probe made the users reflect on also other, closer, relations. Maria and Erica both were very careful to not expose too personal information, especially anger, frustration, and sadness to their colleagues at work.

Maria: “[the sensor could well have (somehow) been automatically capturing my emotional state..] *But.. that would be rather scary in this context, where you don’t want to show. In friendships that is much easier, and you can be more informal. But here, at work, if I’ve had a bad morning, I might not want everyone to know. I mean, if it went ice-blue and ended up in the corner. ‘Oh, how is she?’ but if the same thing happened in close relations, I might get that call from a close friend ‘How are you, my dear?’”*

6.3 Usage in the Mobile Life group

The Mobile Life group sometimes managed to act out both conflicts and to support each other through the probe. They also used it to actively influence the group mood. The group used pictures inside their marbles extensively to express a whole range of matters, such as empathy, understanding, personality, specific emotions, and memories. It is hard to know whether this use started by chance or for some other reason in one group but not in the other. It might have been because the Mobile Life group knew each other better and therefore were more willing to communicate more personal matters and emotions through their pictures. They also used the positioning on the public display far more for emotional purposes and interpreted position on the screen as a dynamic social reflection rather than physical placement of group members. The closeness of these colleagues is also visible in how openly they are willing to share their emotional states, instead of withdrawing as Erica at TeliaSonera did to spare the group of her bad mood. The Mobile Life users also expressed more emotional reactions to what was going on in the display.

6.4 A few days in the Mobile Life group

When Astrid, Eva, and Turid arrive at the office, Phyllis has been alone for a while which is also apparent at the public display; showing a single marble (which Phyllis describes as neutral and awaiting): a green-yellowish marble that is not moving at all. Turid does not feel social today, and wants to wait before getting too engaged in the group. The others upload their expressions right away. Their marbles are moving cheerfully in orange and yellow colours. They seem to be in a good mood, all clustered together. Turid wants to be left alone, not that she dislikes anyone; she simply wants to keep her distance. Hence, she places her marble ‘far from everyone’. She also wants to look calm, so she puts her sensor node outside the window to cool it down and acquire a blue colour. She has a photo of herself that stirs sentimental and sad memories, and she puts it into her marble to see what it looks like on her private screen. She becomes satisfied when she is convinced that the picture is distorted and blurred enough to make it impossible for the others to really see how sad she looks in the photo:

Turid: “It was perfect to have inside my bubble. I knew the picture and what it meant to me, but I was pretty sure that others couldn’t read it. It was a little bit thrilling.”

During the day Turid keeps the picture and calm expression, but moves closer to the rest of the group, as she wants to be more sociable. When Karen arrives, all the marble-bubbles are gathered in a pulsing heap, a happy, bumpy cluster of friends at work.

Karen thinks it looks nice, as if the group is in a good mood and is really comfortable. Karen gets in a good mood by this sight.

Expressing support. Jason’s thesis defence is getting closer. Many years of struggle and hard research work will now be publically examined and Jason is over-worked and nervous about the defence. Karen has felt a strong need to be close to him lately, sometimes she rolls her office chair closer to his and peeks over his shoulder on his computer screen while he is writing his dissertation, to show him her support and presence. Friday morning, right before Jason’s defence seminar, Karen and Phyllis have placed pictures of Jason into their bubbles and moved them very close to him on the public display to show him their support and empathy, see Figure 4.

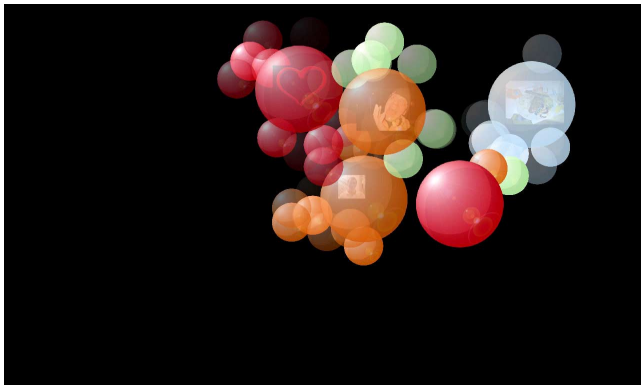


Figure 4. Friday morning before Jason’s thesis defence. Everyone is gathering around Jason’s vibrating and red marble.

Acting out a conflict. Astrid feels the need to be on her own today. She tries to be far away from everyone else on the public display. To strengthen her expression she chooses to use a picture of a very dark evil-looking vampire and uses her sensor node to make her marble vibrate a lot and become orange. At one point during the day there were only two marbles left on the public display; Phyllis’s and hers, see Figure 5, left.

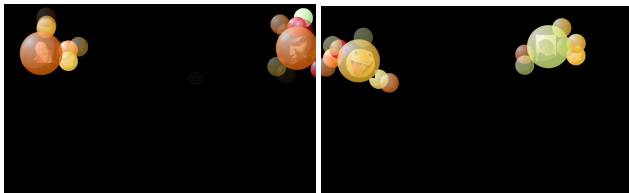


Figure 5. Two similar screen shots but with different meanings. The left picture makes Phyllis mistakenly assume that Astrid is angry with her. In the right picture Astrid is angry

The two marbles were far apart, which might be interpreted as a conflict between them, which is what Phyllis assumed: “*I am not sure, but I think that Astrid is a little bit bitter at me at this point.*”. This time Phyllis misinterprets the causes for the appearance of the display. However, probably this was because there have been other days when Astrid actually had been very angry at Phyllis:

Astrid: “*She (Phyllis) was supervising me, [...] ..., which led to tensions sometimes. I remember one day [when Phyllis’s demands annoyed me] it distracted me from my work. I was already*

stressed [...] and felt that fixing minor bugs in the prototype was rather secondary. To reveal that to others, and especially her, I repeatedly chose ‘far from Phyllis’.”.

At a second occasion, Astrid explicitly wanted to make a point to Phyllis, see Figure 4, right. Phyllis correctly interpreted this as anger but she was in a teasing mood and decided to “battle” with Astrid, by choosing ‘close to Astrid’ many, many times. This action after some time overrides Astrid’s attempts to keep the distance and Astrid and Phyllis’s marbles ended up close together. Astrid then decided to leave things as they were instead of “fighting” back. She did not like the fact that she had to upload so many new marbles in a short time in order to move away from Phyllis. She felt that it made her marble look boring with a lot of similarly colored smaller marbles attached to her larger marble.

Influencing the whole group. One Friday afternoon, Karen tried to get everyone into a cocktail party mood. She chooses a picture of a cocktail bar, and has heated and pounded her node so that her marble is red and jumpy. She is a little bit disappointed that her marble is placed at the edge of the public display and feels that she fails to express what she wants: come over here and join me in my lounge mood. But then she notices that both Jason and Phyllis have joined her in her party mood (see Figure 6); Jason had moved closer to her, and Phyllis has changed her picture to a disco ball, expressing that she is up for whatever Karen has in mind for the evening.

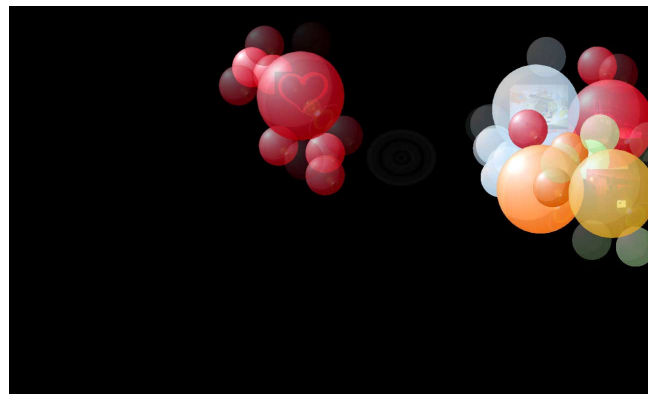


Figure 6. Karen’s (upper right) tries to work up a Friday party feeling and the others (except for Astrid) joined the “party”. Astrid’s marble lingers on the screen from Valentines day, the day before this day.

7. PARTICIPATORY BRAINSTORMING

Apart from the interviews conducted, we also performed a brainstorming workshop (one for each user group) following the interviews held after the two weeks of usage. We let the groups act out how a system similar to the visionary future system described in the introduction, would behave and be designed. We provided the participants with some props, and asked them to imagine that they had a device with sensors of their choice and then act out how this would be used in a social group, co-located or not. The participants produced a range of gestures, possible locations of sensing technology, and suggestions on what kinds of behaviours the solutions must be able to carry/afford. They extensively discussed how to allow for both gentle gestures, such as stroking or patting, and for more negative expressions. Their solutions in many cases involved integrating input and output into one – making the input feel like the output – thereby also getting

rid of the big display on the wall. To express closeness, they wanted to direct their gestures towards the person they wanted to be close to.

Their suggestions showed that they had gained understanding of the material properties of the sensor nodes. But perhaps more importantly, they could link the material properties to the kinds of social behaviours a system like the one envisioned could enable.

8. DESIGNING FOR GROUPS

In short summary, the probe was successful in exposing some of the sensitivities of group communication as well as uncovering aspects of the physical, emotional experiences we were interested in. This whole activity with the probe and the interviews and brainstorming sessions held after the two weeks of usage helped us to extract four key challenges when designing for this kind of non-verbal group communication.

8.1 Group Membership

In real life, we act according to contexts and rules explicitly or implicitly stated in the different communities we belong to. However, it can sometimes be complicated to determine who is included or not in a group and which rules of conduct should be applied. The technology probe we deployed in the two groups in some sense made the social network within these two groups more apparent to its' individuals and exposed some of their practices, or lack of closeness.

In the Mobile Life group it became even more apparent than before how some members of that group are closer to one another than others and how it can be hard to be a newcomer in such a group.

A problem for any group system is the assumption that our friends can be lumped into one group. Erica, for example, (when she was describing her relations to her closest friends, outside work), reflected upon how it was hard for her to even sort those friends into a group constellation:

Erica: *"My friends are not really a group and they have no interest in getting to know each other either and I have no such interest either. If you are part of a group it might be different"*

Both the TeliaSonera and the Mobile Life groups went through thorough discussions on group membership; how it could be more dynamically defined in the system by allowing for individual definitions and set-ups, or how each individual could have their own list of friends. As we can see in the stories above the users compensated for the crudeness of the probe and how it revealed the different ties or lack of ties in the group. They often did so by hiding behind the ambiguity of the expressions of the marble.

Since others, outside the group, could see the public display, it could potentially be embarrassing to show what was going on inside the group to others. But none of the participants said they had hesitated to express themselves on a public display visible also to outsiders passing by:

Maria: *"To them (the outsiders) it was more of a picture, kind of, a nice picture and it might have been animated but then they would not have any clue to what that was really."*

This points to the importance of designing for the group ties in such a way that the meaning-making processes are privileged to those who take part in the group and relationships rather than making crude simplifications and labelling of emotions or

relationships within the group that other can interpret. It must also be possible for the group members to send signals between themselves that not everyone in the group necessarily understands in all detail. Overall, we must be aware of and allow for the fact that groups of friends will not be perfectly balanced – some are more central to the group than the others. We need to carefully deal with the fact that this is potentially very sensitive to the group members:

Astrid: *"The moment I remember best happened on the very first day when I placed my bubble first on the display, so the position was kind of random. Then everyone else up-loaded theirs and for some reason everyone ended up far from me. Even though I am aware how the algorithm works and it... probably was a coincident... it affected me a lot."*

8.2 Mediated Physical Contact

An important insight from our probe experience is that the system mediated a parallel universe of interaction to that going on in the office anyway. By sitting together in an open office space, we were already communicating a whole range of non-verbal cues. The way you sit on your chair, your facial expression, your sighing, or body posture all reveal aspects of what you are doing and what you are feeling. But the probe did not mediate exactly the same signs and signals as your body does. In the office we do not really physically show who we presently feel socially and emotionally close to or far from, but in the probe this was bluntly expressed. Sometimes these possibilities added to the interpretation of what was going on – as in the 'click' war between Astrid and Phyllis.

Emotional closeness, conflicts, and bodily experiences as expressed in the office were transferred, transformed and juxtapositioned against participants' virtual presence and positioning on the public display. What was going on inside the probe was sometimes equally important as what was going on in the office in terms of expressing emotional, physical closeness. It was therefore important to the participants that the system did not portray this in the wrong way. On the public display the individual expressions sometimes ended up on top of each other if wanting to be close to someone, which made both Maria at TeliaSonera above and Hanna at Mobile Life to reflect:

Hanna: *"I wanted to be 'close to Jason', but I didn't want to 'sit in his lap'. That feels too intimate, I want to be close but not on top"*

Physical contact is a sensitive phenomena, it is 'magically' negotiated within a group, of friends, family, colleagues and strangers. There are usually small cues that determine when we can touch another person. By touching another person, you are crossing a border. Designing to allow for touch through a tangible system; i.e. to pet, stroke, pinch, hit, or just being in physical contact, must be designed carefully.

John: *"Some friends you throw yourself at when you meet, and others you don't"*

The conclusion we draw is that while we are designing an alternative universe that might not be based on physical interpersonal expressions, we are still mediating and creating for strong physical experiences. We are opening a new channel for interaction. And within this channel, it must be possible to regulate/negotiate your behaviour so that you do not embarrass others and so that we can express what we really mean. A system

like this should also not limit users' expressiveness. Again, by leaving quite a lot of power into the hands of our users, they will figure out ways to negotiate and repair relationships – without necessarily avoiding expressing neither closeness nor conflicts. The probe did not have enough expressive powers in that sense, but it gave us clues to start working on the next step.

8.3 Physical Bonding Activities

As mentioned above, mediating physical expressions of emotion through technology is very sensitive to users' personality and body language. Sometimes, it becomes too embarrassing to use a technology that throws users out of their comfort zone and they withdraw from the overall experience. For example, a new interaction style that involves gesturing can appear as ridiculous and even disturbing to by-standers, and makes the user too self-aware and possibly embarrassed. However, if you are part of a group, some of the embarrassment can be removed. If everyone else around you is doing the same weird gestures or noise, such activities can even act to strengthen the feeling of being part of a group. In a group of friends, a family, a sport team, etc. it is quite common to find more or less ridiculous physical rituals. It can be doing high fives, specific gestures, coordinated movements when scoring, or “funny faces”. These rituals can be expressions of excitement and emotional group experiences but they also act to strengthen the group. The ridiculousness of the rituals is an act of trust within the group and act to tear down facades and distances. We even believe it is possible to lure similar behaviour in a group that will help to create for stronger emotional ties.

Simply by being part of the study reported here, using those weird-looking sensor nodes, handling them, making noise with them, and having inside information on what it was all about and being able to better than outsiders make sense of the public display, the two groups both expressed how that in itself strengthen their feeling of belonging. Many of them got questions from outsiders about the activity and the expressions on the public display and the participants also said they sometimes felt that colleagues outside the study were envious.

It might be that we need to pull users slightly out of their comfort zone to create for new ways of interacting, and spur closer relationships. At the same time this does not take away our responsibility to design for an interaction that makes sense to users and respects their personality and body language. This brings us to our next key challenges for mediation of non-verbal communication in a group.

8.4 Individual Experience is Key

While our focus is on group experience and sharing in a group of colleagues at work, it became clear to us that expressing ourselves individually is key in what it means to be a member of a group. As individuals within a group we want to be seen and appreciated by the others as individuals and in terms of how we contribute to the group. But it is not only important that other's note the effort you have put into your expression on the public display, it is also important exactly how you, as an individual, is allowed to arrive at your expression. The physical expressivity through the manipulation of the nodes and how well that maps to you as an individual needs to be carefully considered in the design.

When interacting with a physical object the affordance of the interface have effect on the expressions that will be created with that object. If the interface is too sharp and edgy, expressions of

anger and frustration will come easier to hand. On the other hand, if the interface invites to stroking, patting, or other “soft” interaction behaviours, it may exclude the repertoire of harsh, negative, and frustrated expressions.

Erica: *“I found it became difficult because... since you had to bounce this way... it generated movement and whether that was an angry or happy expression was very hard to express. And the bouncing movement, to me, was really a pretty aggressive movement and not like ‘jihoo I am so happy’. If so, I would have liked to shake it more. This made it hard to translate some kind of emotion into it. I tried a bit, but it became the same whether you were annoyed or just happy.”*

This means that it is not only in the interpretation of the group ties that are expressed on the public display that we need to allow for different ways of creating meaning. The same expressive leeway must be included in the choice and design of the physical expressions with the sensor nodes. They must be able to engage in different meanings. If you feel happy, you should be able to express happiness and also be encouraged by the form of the interaction device to do so. Happiness should also be the response you get to see on the display (or whatever output means the system has) to strengthen the feeling of happiness and so forth. This is why we need to aim for express leeway instead of specifically labelled expressions in a crude one-to-one mapping. We do not want users to have to formulate what they want to express and then try to consciously translate that into gestures with the device, but instead express how that sensation feels. The aim is for interaction to allow users to do as they feel and not force new physical interaction patterns onto our users that make them disengaged with their experience. As discussed above, the probe was consciously designed to be a bit rough – definitely not providing for a supple experience along the lines of Isbister and Höök's definition above – but suppleness is what we need to consider here.

9. REVISITING THE DESIGN SPACE

Designing for non-verbal expressiveness is difficult, and it is even more difficult to involve users in a productive way where they can understand what is possible and contribute their own understanding and creativity. Our technology probe experience showed us that a fairly rough implementation was successful in involving both ourselves and the other participants in living and experiencing the possibilities. The slight provocations we included did help us uncover sensitivities in group communication. It allowed us to experience the material that can be created from a combination of sensor node interaction and group communication. The simplicity of the probe allowed for creative and fruitful discussions between researchers and users.

However, some of the roughness or “non-decisions” in the FriendSense probe affected the interaction and user experience. For instance, the closeness between users' marbles had to be expressed through a client on each user's computer. This effectively broke the connection between gestures and expression on the screen as users had to let go of the node and click in menus to say who they wanted to be far/close to. A more subtle design would have given us more rich and better ideas for design. Even though a technical probe is a method during the design process to get to ideas of a future system, a more carefully designed probe allows for more insightful ideas. A technical probe needs its own

design process but it can most often be kept rather small and simple.

The design process of the FriendSense probe involved a few iterations in finding the best “translation” of the sensor data into the graphics on the screen. We were a little held back by the rough hardware technology we used for the FriendSense probe to get a quick start in implementing a working system. The idea was that vibrations would translate into “marble-movement” expressing arousal [26] and temperature would map to colour made to somewhat resonates with Western culture mapping of temperature to colours and indirectly from colour to value (pos – neg) of expression. This was the most minimal design we could imagine that still had enough expressive power for the given purpose and that would provide for a clear mapping. In the study, we discovered that the nodes only allowed for the more negative expressions – a disappointment. We had assumed that light shaking or light touch of the temperature sensor would afford caressing movements.

The ultimate goal is to produce a system that much more gracefully and subtly translates physical expressions with/through the sensornodes into expressions – preferably not on a screen but existing on/in the sensornode itself and between the users’ nodes, using other interaction modalities such as for example haptics.

Most important to us were the experiences of expressing ourselves non-verbally to one-another. In particular, we need to consider the need for both expressive leeway to fit with individual taste and personality, and at the same time making sure that the physical act properly corresponds to the inner experience of what we want to express. A design challenge lies in integrating input and output into one – making the input feel like the output – as expressed in the brainstorming workshops.

We learnt a lot about the work we all do in keeping a group alive and healthy. Overall connectedness and emotional closeness have been treated too much from the perspective that we should only design for the positive aspects of friendships [3, 7, 20, 21, 27] in the HCI literature – some-times in stark contrast to what people actually use the systems for. With a rather blunt probe we opened up for conflicts and tensions to be acted out, thereby providing a less naïve perspective of friendship and emotional closeness.

We found that a jointly created expression provided an arena for the group to express itself, acting out both conflicts and closeness. The expressions in turn influenced the group and its individuals. It was even used as a tool to deliberately try to influence the group. Risks involved excluding members of the group or misinterpreting what was going on, however, activities that also are part of relationships and what makes them so interesting and engaging. Relationships are sometimes both strong and fragile and needs careful attention.

Commercial systems, like Kareokee, Dance Dance Revolution, Sing Star, Guitar Hero, Rock Band, and Wii, are in some ways relevant to what we are aiming for here. They do force users out of their comfort zones, they allow for groups of friends to have fun together, and their physical form is carefully designed to harmonise with the experience of the system, though none of them explicitly deals with presence and awareness of friends’ activities.

In summary, our probe allowed us to uncover what is needed to design for an interesting physical, emotional expressive channel

that can serve as a parallel, somewhat different, universe, able to strengthen group ties by allowing for individual, physical, emotional expressions contributing to a joint group-created, aesthetically pleasing whole.

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