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Chapter 16

AMBIENT DISPLAYS AND MOBILE DEVICES FOR THE CREATION OF SOCIAL ARCHITECTURAL SPACES

Supporting informal communication and social awareness in organisations

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Abstract: In this paper, we address three major issues, look at their interaction and combination and present our results on how to arrive at solutions for these issues. The issues are: 1) supporting informal communication and atmosphere in organisations, 2) the role and potential of ambient displays in future work environments, and 3) the combination of mostly static artefacts that are integrated in the architectural environment with mobile devices carried by people. Our results can be considered as steps towards the design and realization of what we call "social architectural spaces" in the context of future work environments. These environments will be populated with a range of different smart artefacts that are designed to facilitate awareness and notification as well as informal communication. We address a range of spaces in office buildings including public spaces, e.g., in the hallway, the foyer, and the cafeteria that have not been the focus of research so far. In particular, we present two artefacts: the Hello.Wall, a wall-size large ambient display, and the ViewPort, a mobile handheld device. They are interacting with each other via wireless networks and different types of sensing technology. The artefacts and the software were developed in the EU-funded "Disappearing Computer"-project "Ambient Agoras: Dynamic Information Clouds in a Hybrid Worlds".

Key words: ambient displays, mobile devices, informal communication, atmosphere, social architectural space, ubiquitous computing

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INTRODUCTION

The role of information and communication technology for the next generation of work environments and office buildings will go beyond its use as mere productivity tools. Information technology will also play a major role as a medium and mediator for supporting informal communication and conveying social awareness and atmospheres in organizations. This is due to new technology developments as well as an increased awareness of and interest in the role of informal communication in work environments. While people have acknowledged the importance of soft skills and social competence for quite some time, the value of informal communication for the performance and the creativity of an organization tends to be underestimated. Against this background, there has been very little work on computer-supported augmentation of informal communication.

Two trends are changing this situation: The trend of putting more emphasis on informal communication and the trend in new technology developments not to restrict computer-based support to the PC workplace anymore, but to support mobile and ubiquitous computing using a wide range of devices. This observation is especially shared by consultants and architects planning new office buildings or restructuring existing ones according to new requirements (Pietzcker, 2002). Informal communication is considered to play an important role for facilitating creativity and innovation as the following statement of the architect G. Henn shows: "80% of innovative ideas created in offices are a result of informal personal communication - despite worldwide data and communication networks. In order to increase the performance, office buildings have to foster and structure the communication between employees. In this way, architecture provides a catalytic function." (Remmers, 1999, translated from German,) In this context, computer-based support for informal communication becomes an important topic when designing the workspaces of the future in terms of what we have called ‘Cooperative Buildings’ (Streitz et al., 1998, 2001).

Informal Communication plays a major role in an organization’s ability to learn. According to Lave and Wenger (1991), shared interests, shared expertise and the passion for joint enterprises are the main attributes that keep a community creative and competitive. Informal communication is also considered to compensate the weaknesses of the formal flow of information, to mediate the organization’s culture and values, and to enhance the social relationships within a team (Schütze, 2000). Besides these social functions, informal communication also serves task-related issues: It supports short-term coordination (Fish et al., 1992) and the mediation of specific knowledge (Held & von Bismarck, 1999).

Kraut et al. (1990) have introduced the typologies of informal communication as: scheduled, intended, opportunistic or spontaneous exchanges. Ishii et al. (1998) show that the majority of interactions are brief, unscheduled, frequent and dependent on physical proximity. 80%-90% of interpersonal interactions in the workplace are not planned meetings; but, according to Schütze (2000), informal communication supported by media does not take place. We argue that this is due to the nature of PC workplaces and propose that employing a broad range of ubiquitous computing devices could help to augment informal communication in organizations.

A prominent augmented computing device supporting informal information-flows within an organization is an ambient display. We interpret ambient displays according to Grasso et al. (Chapter 11 this volume) as "large public displays pushing information to trigger synchronous and asynchronous informal interactions in organizations". We also consider the special perceptual conditions described by Wisneski et al (1998) for ambient displays: At the "periphery of our attention" with a kind of "subconscious understanding" and - possibly "engaging all our senses". Furthermore, contemporary architects as, e.g., Gunter Henn (2002) claim that flows of information and knowledge within a building should become a visible component of the building. Ambient displays can help to make these flows accessible.

In this paper, we investigate how ambient displays support informal processes and communication within a corporate building and present an example for the use of an ambient display combined with a mobile device serving this function. We propose that a calm and ambient technology such as our *Hello.Wall* (described below) empowers the user to decide when to focus on and when to ignore provided information. The use of calm technology facilitates the awareness of processes, atmospheres and activities without interruptions or disturbances. The social affiliation in local as well as remote places can be strengthened because of additional awareness of people's activities. Information reaches the attention of team members in a subtle and peripheral way: Users do not pay attention to the stress level, but subconsciously feel the "atmosphere". This is in accordance to the natural ambient displays described by Wisneski et al (1998) as follows: "A sound of a passing neighbour, a shadow at the fringe of our visual field, etc."

In the following sections, we describe our ideas and prototype implementations of what we call a "social architectural space" that facilitates new types of supporting social awareness and communication in organizations. Informal communication and associated social interactions create and involve atmospheres. Our proposal is to develop 'smart artefacts' that are integrated into the architectural environment (here with a focus on ambient displays) as well as mobile devices in combination with appropriate software. Integration can but does not necessarily mean "to bake the artefacts into walls". Even larger artefacts can also be mobile elements and can be positioned at different locations in a building.

In such an environment, parameters derived from the activities of people in the building (or in another location) can be transformed into data representations, displayed and thereby influencing the atmosphere itself. This setup may cause feedback loops, where the display of atmosphere enhances and influences the relevant parameters more or less directly. Communicating atmospheric aspects of an organization includes general and specific feedback mechanisms that allow addressing different target groups via different representation codes. Individuals as well as groups can create public and private codes depending on the purpose of their intervention. The content to be communicated can cover a wide range and will be subject to modification, adjustment, and elaboration based on the experience people have.

An artefact such as the proposed Hello.Wall will allow us to experience formerly invisible, abstract parameters, e.g., activity patterns, now sensually, e.g., by means of light patterns shown on an ambient display. In all cases, it is important to address the information and communication needs of the people involved. One aspect is 'transparency of relationships'; another one is the availability of 'light-weight means for communication'. An important issue is what kind of 'means' can be provided. We are looking at new means that also remedy some of the problems with existing state-of-the-art tools of communication. For example, email has the advantage of communicating explicit information which at the same time is also a disadvantage because of the need to create words and sentences, etc. and its shortcoming to convey information in other ways.

If the type of information to be communicated is more of an atmospheric nature, the way to present and to perceive this information should clearly go beyond standard means as they are currently provided by PCs. This can be achieved by exploiting the human ability to perceive information via many different codes. These can be specific in nature but do not require a level of coding as with words. Furthermore, it is useful to facilitate the "display" and perception of information as a secondary activity in the periphery while being concerned with another primary activity. In this respect, we go beyond contemporary approaches to support informal communication between distributed and co-located team members as e.g. Greenberg & Rounding (2000) suggest. Their Notification Collage is a real-time collaborative surface that allows individuals to attach post-it notes and video streams to a shared surface to foster both formal and informal exchange. While this works appropriately at private desktop machines, the Notification Collage's information cannot peripherally be grasped, because it adheres to the coding of words and sentences. This does not only hamper peripheral perception, but also aggravates the implicit creation of new information due to the explicit nature of words and sentences. Another system called Web Wall (Ferscha & Vogl, 2002) shares most of the characteristics of the Notification Collage. While it lacks the integration of real-time video streams, it leaves the desktop PC metaphor by using mobile devices such as cellular phones to alter the state of the Web Wall. This is a first step towards addressing the integration and fusion of information technology with the architectural space in that creating information is no longer bound to the keyboard on the desk in the office. The architectural dimension is important, because it brings the means of supporting communication back to the location where most of the informal communication takes place, i.e. the hallway, the foyer, the cafeteria, the staircases in contrast to the desktop computer in the office.

Thus, the goal is to create a computer-augmented social architectural space that is inspired by the capability of humans to perceive and to interpret ambient information in order to convey the ‘feeling of the place’ or ‘genius loci’.

OUR APPROACH TO AMBIENT DISPLAYS

Ambient displays take a broader view of the notion of display usually encountered with conventional graphical user interfaces (GUI) found on PCs, notebooks, PDAs and even on many interactive walls or tables. They are designed to display information without constantly demanding the user’s full attention. Usually, this is achieved in a more “implicit” way compared to traditional “explicit” GUI displays.

Ambient displays are envisioned as being all around us and thereby moving information off the more conventional screens into the physical environment. They present information via changes in light, sound, movement of objects, smell, etc. For early examples by Ishii and his Tangible Media Group at MIT Media Lab see Wisneski et al. (1998). Other examples have been provided by, Greenberg et al. (Univ. of Calgary), Mankoff and Dey (UC Berkeley), Mynatt et al. (GeorgiaTech), and Heiner et al. (Carnegie Mellon University).

In this paper, we propose and present the *Hello.Wall*. It is a new large ambient display that emits information via light patterns and can also be considered informative art. It has been designed to be both a stimulating illuminated wall element and a distance- and person-dependent information transmitter. The Hello.Wall is combined with the ViewPort in order to extend the general ambient-displays' approach by combining it with mobile devices that act as complementary sources of information. Depending on their access rights (personalization) and the current situation (e.g., distance to the wall; see below), people can use ViewPorts to decode visual codes (here, light patterns), to download ("freeze") or just browse information, to paint signs on the wall, or to access messages announced by a light pattern. This addresses also the issue of avoiding the privacy problem of public displays.

Hello.Wall

The Hello.Wall is an ambient display transmitting organization-oriented information publicly and information addressed to individuals privately. One can think of it as an organism that radiates the 'breath' of an organization's social body and thereby makes it perceivable towards the inside, i.e. the members of the organization, as well as towards the outside, for example to visitors. Atmospheric aspects are mapped onto visual codes realized as light patterns which influence the atmosphere of a place and the social body around it. While the Hello.Wall serves a dedicated informative role to the initiated members of the organization, visitors might consider it as an atmospheric decorative element and enjoy its aesthetic quality. As an integral part of the physical environment, the Hello.Wall constitutes a seeding element of a social architectural space that provides awareness to the members of the organization.

In this way, the Hello.Wall is a piece of unobtrusive, calm technology exploiting humans' ability to perceive information via codes that do not require the same level of explicit coding as with words. It can stay in the background, only perceived at the periphery of attention, while one is being concerned with another activity, e.g., a face-to-face conversation.

ViewPort

To complement the Hello.Wall, we propose a mechanism where the Hello.Wall can "borrow" the display of other artefacts, in order to communicate more detailed information. These mobile devices are called ViewPorts. Due to the nature of the ViewPort's display, the information shown can be more explicit and more personal because it is viewed on a personal or temporarily personalized device. Depending on their access rights and the current context, people can use ViewPorts to learn about the purpose of the Hello.Wall system, to decode visual codes on the wall, or to access a message announced by a code.

DIFFERENT ZONES OF INTERACTION

In addition to developing a new type of ambient display, our goal was also to make the type of information and the way of its communication context-dependent. The service provided by the artefact should be location- and situation-based depending on the proximity of people passing by. We distinguish between three different "zones of interaction" and their respective modes (see figure 16-1) dependent on the distance from the Hello.Wall:

- Ambient Zone
- Notification Zone
- Cell Interaction Zone

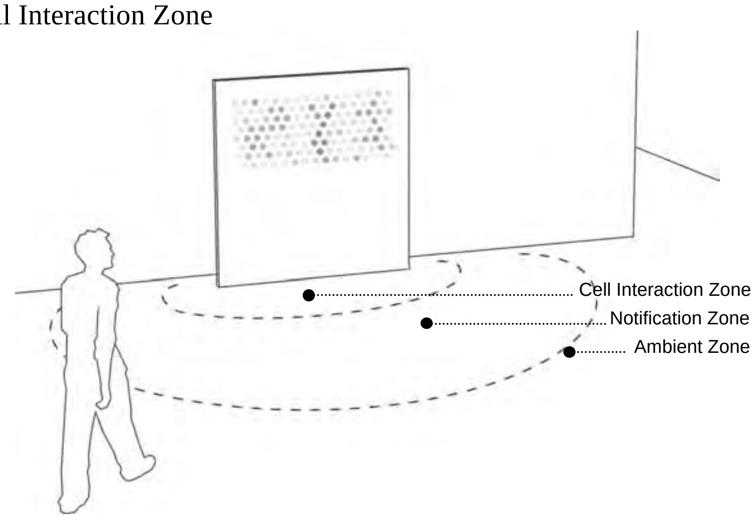

Figure 16-1 Three Zones of Interaction

This is achieved by integrating sensors into the walls that cover two ranges, which may be adapted according to the surrounding spatial conditions. The sensors allow us to introduce "distance-dependent semantics", implying that the distance of an individual from the wall defines the kind of information shown and the interaction offered.

Ambient Zone

When people are passing by, but are outside the range of the sensors, they experience the "ambient" mode, i.e. the display shows general information that is defined to be shown independent of the presence of a particular person. The parameters chosen to define the atmosphere are represented as light patterns. The pattern shown in the ambient mode could also be called the “stand-by” pattern. Examples are: the number/ percentage of people still in the building, levels of activities, etc.

Notification Zone

If an individual approaches or passes by close to the wall, the person enters the Notification Zone and the wall will react. The Hello.Wall changes from a stand-by pattern to a notification pattern. This pattern can be a personal pattern relevant only for that particular person or a group pattern that is shown to all members of that group when passing by. These patterns can be “secret” and only known to the people that are notified. While the notification serves already an important purpose, in many cases there is a need to receive more detailed information. This is achieved by combining an ambient, implicit display with another explicit display. We propose a mechanism that we call “the principle of borrowing a display”.

Figure 16-2. Interaction at the Hello.Wall using the ViewPort as a borrowed display.

In our approach and realization, we use a mobile PDA-like device called “ViewPort”. The Hello.Wall borrows the display of the ViewPort and the user has all kind of information “at hand”.

This includes also a help-function that could explain the meaning of certain patterns. Depending on the actual application, the user can interact and also enter data, download (“freeze”) or browse information (See figure 16-2).

Cell Interaction Zone

The third zone is active, once the person is very close to the Hello.Wall. In this case, the person can approach the Hello.Wall and interact with each single cell (= independent interactive ‘pixel’). This is able to store and communicate information in parallel in combination with mobile devices. This feature allows playful and narrative interactions, which other media don't supply. There is also a charming element of surprise that may be discovered via the single cell interaction, because before accessing the cell, there is no hint, what will be revealed.

DESIGN CONSIDERATIONS FOR HELLO.WALL AND VIEWPORT

With respect to being a stimulating architectural element, the Hello.Wall artefact and also the light pattern language have been designed to have a blurred and rather abstract appearance. As Wolfgang Ulrich (2002) put it: "The more blurred a picture is, the more likely it will serve as a projection surface for the thoughts of its observer." In addition, we work mostly with dynamic light patterns. Although recognizable to users, they are not being predictable and thereby introducing an element of chance or surprise.

The satin-coated Hello.Wall artefact consisting of snow-white acryl as well as the ambient light patterns for the Ambient Zone are pieces of unobtrusive calm technology. The ambient patterns are unobtrusive, because the deltas in movement, in amorphic form changes, and in light intensity are smooth and waving and thereby stay within the periphery of the users' attention. This matches their purpose of mediating qualitative, atmospheric, and rather blurred information. Compared to the ambient patterns, the notification patterns for the Notification Zone, overlaying them and emerging from them, are sharp and more distinct in quality. This again matches their purpose of catching the user's attention when entering the Notification Zone. But still, they can be quite easily ignored.

We take a scenario-based approach to the design of a pattern language as can be seen from the application scenarios presented later. There are some generic feedback and notification elements that are invariant while being complemented by scenario-specific patterns. In addition, for small groups of people, we create personal notification patterns.

The content to be communicated via ambient patterns can cover a wide range and will be subject to modification, adjustment, and elaboration based on the experience people have. The atmospheric aspects of an organization might include general or specific feedback mechanisms that allow addressing different target groups via selected codes that are accessible only for a defined group or individual. Individuals as well as groups can create public as well as private or secret codes depending on the purpose of their intervention. More complex content can be communicated either via the explicit ViewPort display or via more complex light patterns, where combination is achieved either spatially or through sequencing.

Because the newly created pattern language have to be learned by the users, we prefer to keep the patterns simple. We work with simple metaphors in pattern design as can be seen from the examples below. Users can use ViewPorts to decode patterns, but they can also define their own patterns in order to make it is easier to remember them. Some patterns need to become common knowledge within the Hello.Wall's user community, be it people at a certain place or members of a team.

SAMPLE APPLICATION SCENARIOS

We defined the general goal of developing new means for the support of informal communication and awareness of social atmospheres and proposed a general approach in terms of the types and artefacts. Now, we describe sample scenarios as examples of social situations. This is to provide an idea on how these means can be used.

Presentation Scenario at DC Jamboree 2002

The first public presentation of the Hello.Wall occurred in the fall of 2002, at the second Jamboree and public exhibition of the EU-funded proactive research initiative 'The Disappearing Computer' (DC). Visitors of the Jamboree exhibition were asked to take part in an opinion poll regarding the DC Jamboree, the jointly held UbiComp 2002 conference, and their general mood. Two ways of voting were provided. People could either use arbitrary computers and a web interface or the ViewPort in combination with the Hello.Wall.

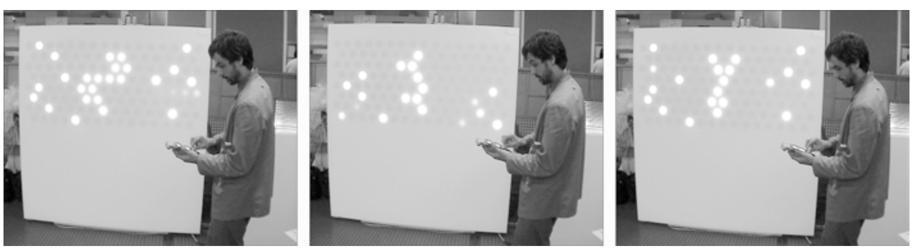

Figure 16-3. Ambient patterns

This example shows awareness and notification patterns on the Hello.Wall related to the opinion poll, users voting for this poll, and users playing a game. In the ambient mode, i.e. from a distance and without interaction, the system displays the present state of the opinion poll. From left to right, the ambient patterns shown in figure 16-3 represent the poll states regarding the DC Jamboree, the UbiComp conference, and the general mood of users. These patterns were looped.

Figure 16-4. “Send” pattern to catch the user’s attention

Visitors are equipped with a tag and the ViewPort prototype. When approaching the Hello.Wall, they are sensed and thus enter the Notification Zone. Once inside the Notification Zone, the Hello.Wall displays the “send” pattern (see figure 16-4) asking the approaching user to look at the ViewPort.

Figure 16-5. Examples for explicit feedback on the ViewPort

Inside the Notification Zone, people are welcomed, given a short introduction about the displayed patterns and then asked to take part in the poll. The first three pictures in figure 16-5 are sample ViewPort screens from this interaction sequence

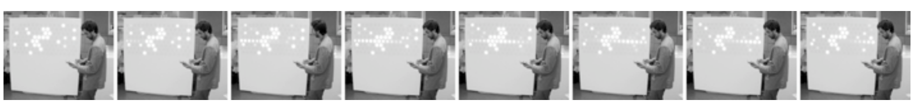

Figure 16-6. Interaction feedback on the Hello.Wall

Each time users answer a question, the Hello.Wall immediately changes to the corresponding ambient pattern and shows an illuminated light stroke crossing the Hello.Wall from left to right in order to acknowledge the input (see figure 16-6).

Figure 16-7. “Smile” pattern (‘thank you’)

When users submit the last question of the poll, the Hello.Wall gives them a “smile” while at the same time the ViewPort explicitly thanks the user for his attention (see figure 16-7). Users are then invited to play a game, i.e. an adapted version of Memory (see figure 16-8) while the “memory” pattern is displayed on the Hello.Wall, which consists of randomly distributed static light points.

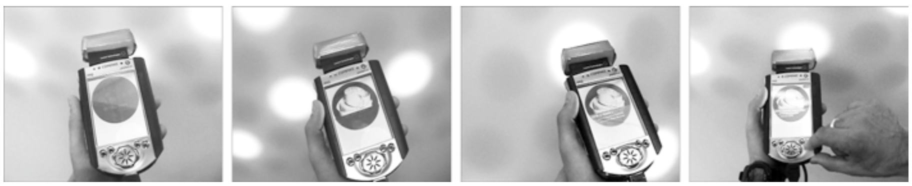

Figure 16-8. Playing Memory using an earlier ViewPort prototype

If interested and attracted, the users can approach the Hello.Wall and thus enter the Interaction Zone. Playing Memory, users uncover single light-cells of the display one after the other while searching for matching pictures which are displayed on the ViewPort. It has to be noted that multiple users can play this game in parallel, since the cells are independently interactive.

Further Sample Scenarios

In this section, we present four application scenarios that are taken from a video produced for the UbiComp 2003 conference (Prante et al., 2003).

ActivityCapture

The Hello.Wall system captures and radiates the general atmosphere in an organization or at a place to invite people to reflect upon and act accordingly - reflection in action. It is based on monitoring and sampling sources of atmospheric aspects: Deadlines, todo-lists, physical activities, nature of movements and sounds, physiological parameters, the way people interact with digital data, etc. Atmospheric aspects to be mapped onto light patterns could also be extracted from conversations (Basu et al., 2001).

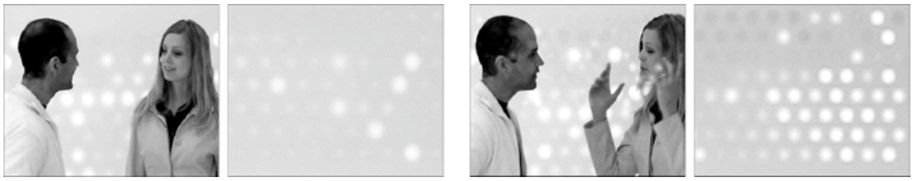

Figure 16-9. A calm pattern (left) and a more pulsating pattern (right)

An overall relaxed atmosphere in an organization is captured and reflected by the system displaying a calm visual code. Increasingly nervous and vibrant activities lead to more dynamic and pulsating reflections on the wall (see figure 16-9).

HaloCapture

Beyond reflecting the general atmosphere, the ambient display can also distribute more specific and directed information through luminous codes. As an example of a code that is known to the whole organization, we propose the halo-pattern that mediates commendatory comments.

Figure 16-10. Mediating commendatory comments

Outstanding performances are publicly rewarded by this pattern, when the particular individual is sensed by the Hello.Wall (see figure 16-10). Depending on access rights, people can view more detailed information using ViewPorts. Other people passing by and noticing the halo-code can take this opportunity to say something nice to the awarded person (see figure 16-10.).

InitCapture

To form a team, it has proven useful to gather the potential members face-to-face. The communication flow is rich, direct, and can create an atmospheric and powerful experience. Team-building processes are initiated and trust can grow. To define and show membership of groups, people have always used codes, sometimes visual. We emphasize a sense of belonging to the same team by having a "secret" code that is known only to the group.

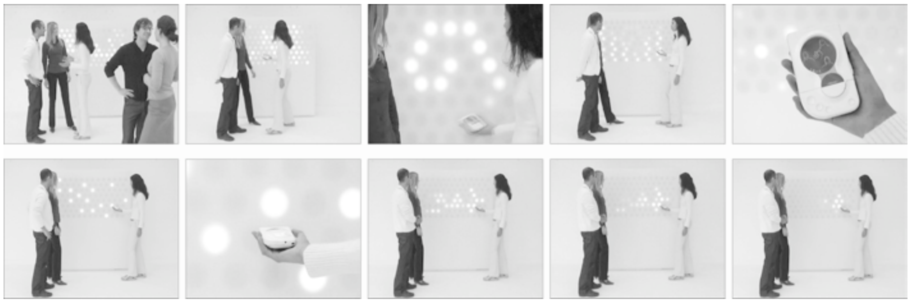

Figure 16-11. Team initiation at the Hello.Wall

For the following, please refer to figure 16-11. Members of a team to be initiated gather at the Hello.Wall. As a sign of identification and belonging, they define their "secret" visual code. The system senses the team members, registers their code, and sends an affirmative feedback - explicitly, which can be viewed using a ViewPort and a visual code radiated by the wall. As the system now knows the team, it loads up the mebers' prepared work folders related to this meeting. The results are immediately shown and can be accessed by the team members cell by cell or all at once. Please note that simultaneous interaction using several ViewPorts at a Hello.Wall is supported as well.

Team-specific ActivityCapture

When people work together, they maintain awareness of each other helping them to coordinate activities and find opportunities for collaboration. This group awareness involves several types of knowledge about what is happening in one's collaborative environment. One example of group awareness is knowledge about the activity level of one or more group members.

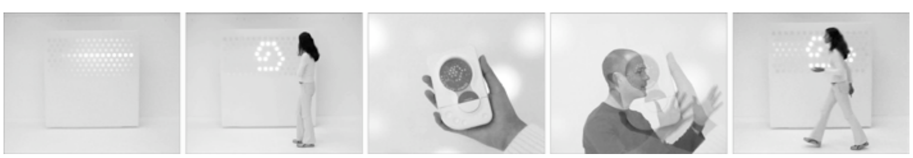

Figure 16-12. Mediating activity levels among team members

Publicly known atmosphere-emitting visual codes in combination with visual codes defined by a team are used to mediate activity levels among the team's members (see figure 16-12). In addition to helping with coordination and pointing to collaboration opportunities, this provides an ambient medium for keeping yourself aware of the vibes within a team.

Installation for User Testing at EDF-LDC

As part of our user testing efforts in the Ambient Agoras project, the Hello.Wall has been installed at the site of our cooperation partner Électricité de France (EDF) at the Laboratory for the Design of Cognition (LDC). We have created a second version of the activity-pattern.It reflects both the atmosphere and the activity level at a place or within a team.

Figure 16-13. Second version of activity-pattern (very low)

First, the better the atmosphere, the bigger the amount of light in the waving patterns. Second, a low activity level is represented as only a few light “tails” ascending, whereas a higher level of activity results in more light “tails” ascending.

Figure 16-14. Second version of activity-pattern (very high)

Figures 16-13 and 16-14 present the two extremes of the activity-pattern.

REALIZATION OF HELLO.WALL AND VIEWPORT

For the prototypical realization of our ideas, we decided for a combination of stationary and mobile artefacts. In this section, we describe the technical realization of the Hello.Wall artefact as an element of the architectural space and the ViewPort artefact as a mobile device that can be sensed and interact with the Hello.Wall in various ways.

Hello.Wall – Artefact and Technology

The Hello.Wall is a stationary artefact with integrated sensing technology. It does not have a standard type of display but is able to "display" or communicate ambient information.

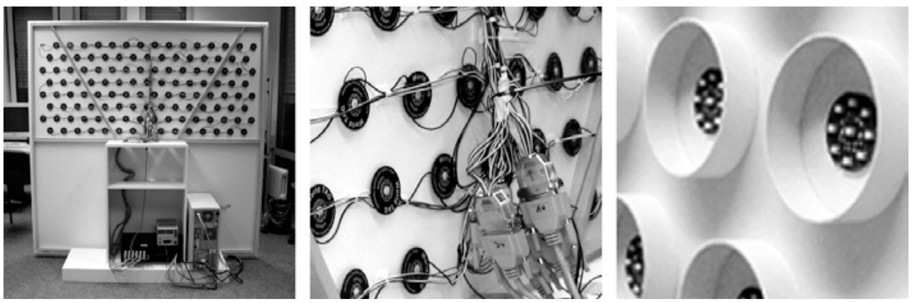

Figure 16-15. From left to right: rear view of the Hello.Wall; wiring and transponders for each InformationCell; InformationCell with LED cluster.

Sensing Technology

For the identification of artefacts and individuals we decided to develop a two-stage detection hierarchy consisting of two independent RFID systems. To guarantee an interference-free overlap of the electromagnetic fields, both systems operate in different frequency ranges. For the detection of by-passing individuals or mobile devices we use a passive long-range-system with two large-scale antennas, which are integrated in the lower part of the Hello.Wall. This enables us to detect up to 50 tagged objects per second within the Notification Zone.

In addition, each of the 124 cells at the Hello.Wall contains an LED cluster and a short-range transponder (see figure 16-15). Hence each InformationCell is unambiguously identifiable by mobile devices equipped with short-range readers. For clear identification of each cell it is essential that the electromagnetic fields of the adjacent transponders do not overlap. To ensure interference-free reading the transponder's antennas are tuned to cover the whole cell without affecting the transponder fields in neighbouring cells.

Driver Interface

The Hello.Wall artefact is controlled by a standard PC using a special driver interface. To adjust the brightness of the LED clusters we developed a control unit using pulse width modulation. Figure 16-16 shows the schematic layout of the developed circuit board. The complete driver interface consists of 16 Circuit boards and an additional board for the generation of a reference signal.

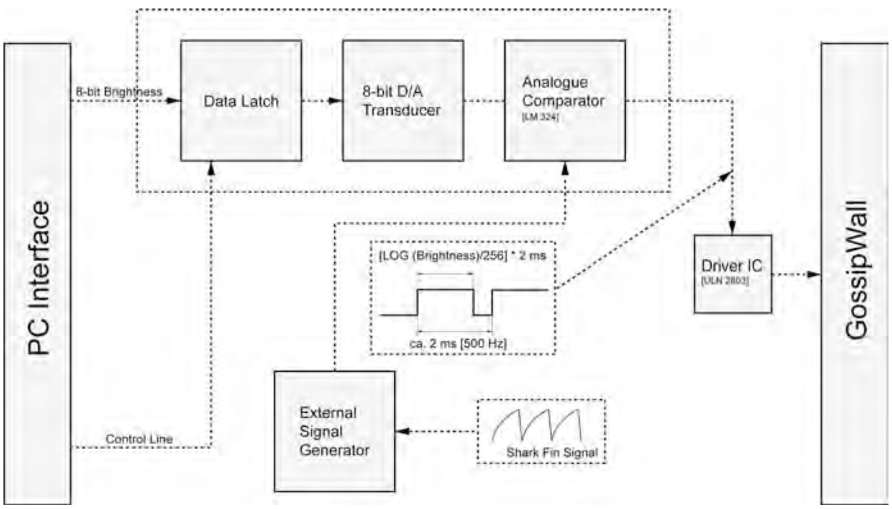

Figure 16-16. Schematic layout of the driver interface for one LED cluster.

The brightness value for each LED cluster is stored in a data latch. A D/A converter transforms this value into a direct voltage U_D. The resulting output voltage is then stabilized by an operational amplifier (op-amp). To receive smooth transitions between sequencing brightness levels, a capacitor is connected to the positive input of the op-amp. Hence the luminescence of the LED clusters can be determined by the size of the capacitor.

As a reference signal for the comparator we use a 500 Hz signal, which is provided by an external signal generator. Minimum and maximum values of the light intensity can be tuned with two trim potentiometers by adjusting the zero-point and the amplitude of the reference signal. A second op-amp is used to amplify this signal, before it serves as a reference input for the analogue comparators. The output of the comparator is “high” as long as the voltage U_D is higher than the reference signal. This results in a pulse width modulated signal with a cyclic duration factor that is exponentially dependent on the voltage U_D and hence the brightness.

ViewPort – Artefact and Technology

The ViewPort is a portable artefact with a pen-based interactive display and integrated sensing technology. It can be used as a personal, temporarily personal or public device for creating and visualizing information. It also provides the functionality of visualizing information “transmitted” from other artefacts that do not have displays of their own and are "borrowing" this display as, e.g., the Hello.Wall. The current version of the ViewPort comprises the concept of having two parts of a display, e.g., to differentiate between a private and a public part of a display. This is to be responsive to the fact that sharing of information will be ubiquitous in smart environments and keeping personal data private will be a major challenge. Active mobile devices such as the ViewPort are key components of a smart environment.

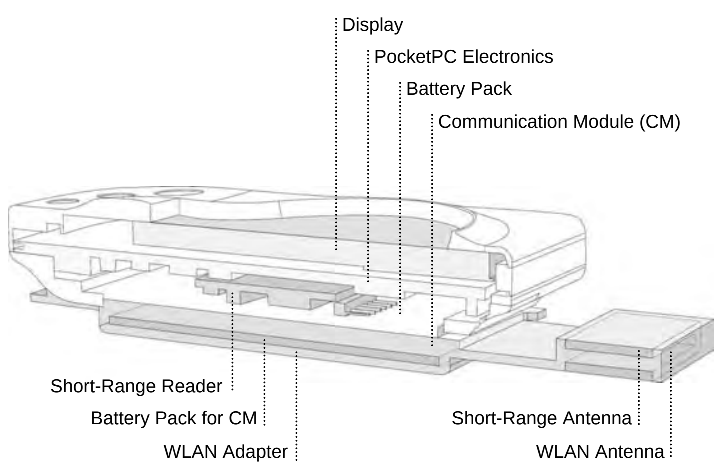

Figure 16-17. Cross-section of the ViewPort

The ViewPort is developed on the basis of a PocketPC (Compaq IPAQ series) with a 200 MHz processor and a touch-sensitive color display. Its functionality is extended through a passive short-range reader unit and a wireless LAN adapter (see figure 16-17).

The integrated RFID reader operates with a frequency of 125 kHz and allows reading ranges up to 100mm. In addition, the ViewPort is equipped with a long-range RFID transponder. Thus the ViewPort can be detected by stationary artefacts in the environment, e.g. the Hello.Wall, while at the same time identify nearby artefacts through its own reading unit. The software developed for the ViewPort is able to establish a connection to the Hello.Wall via a WaveLAN link and to utilize the short-range sensors of the ViewPort hardware. This combination enables the device to offer services that are aware of the context in terms of the spatial information of the ViewPort device and the state of the Hello.Wall.

Interaction between Hello.Wall and ViewPort

Since by-passing individuals can be recognized, there is a range of interaction opportunities including individual information through mobile artefacts as well as anonymous and public communication.

To support the interaction between the different components we use two independent RFID systems and a wireless LAN network. People within the Notification Zone are detected via two RFID long-range readers installed in the lower part of the Hello.Wall. Once a person is detected the identification information is send to the controlling PC for further processing. Depending on the kind of application, data can be transmitted to the ViewPort via WaveLAN or distinctive light patterns can be displayed for notification. Within the Interaction Zone, people can access the information “stored” in each cell by reading the cell’s ID with the integrated short-range reader of the ViewPort. With the received data the ViewPort can access the corresponding information stored on the controlling PC. The following figure (figure 16-18) shows a schematic sketch of the ViewPort and the Hello.Wall coupled via RFID technology and wireless LAN to enable a coherent, engaging, and even immersive interaction experience.

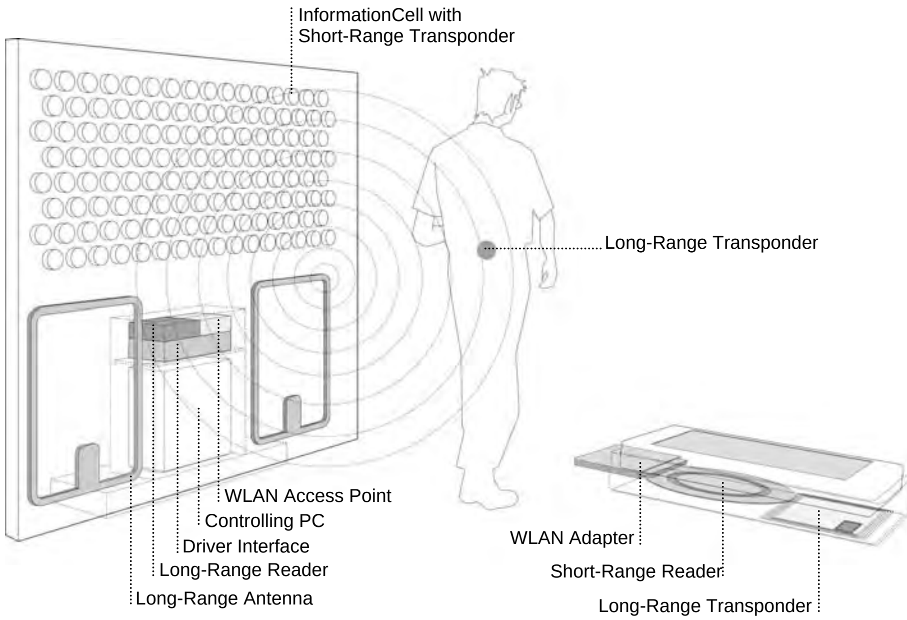

Figure 16-18. Communication and Sensing infrastructure of Hello.Wall and ViewPort

CONCLUSIONS

In this paper, we presented the concept, design, and implementation of a new combination of ambient displays with mobile devices in order to facilitate and convey informal communication and atmospheres in organizations. Our overall goal is to augment the architectural envelope in order to create a social architectural space using means beyond traditional architectural elements, furniture, or standard information technology. The approach is an example of changing and expanding the role of information and communication technology for the next generation of work environments and office buildings. It will go beyond its mere use as productivity tools by playing also a major role as a medium and mediator for supporting informal communication and conveying social awareness and atmospheres in organizations. In the EU-funded project “Ambient Agoras”, where these artefacts were developed, we also use the metaphor of transforming places and spaces in office buildings into marketplaces (= “agora” in Greek) of ideas and information in order to indicate this change of purpose.

Our own previous work on computer-based support of activities and work processes that went beyond the single-user desktop PC scenario was very often concerned with support for team work in electronic meeting rooms (Streitz et al, 1994). The work presented here extends not only this direction but also our subsequent development of the i-LAND environment (Streitz et al, 1999) and the second generation of Roomware® components (Streitz et al, 2001).

There are three major differences. First, we extended the content to be dealt with from productivity-oriented information to information about states of people and the organization, e.g., presence, activity levels, attitude, atmospheric information, etc. Second, and partly as a consequence of this change in content, we are exploring new means for communication that are different from the standard explicit displays resulting in implicit and ambient displays, in our case the Hello.Wall. Third, we introduced a mobile handheld device with a new form factor, the ViewPort, a device that can be "borrowed by other artifacts" as, e.g., the Hello.Wall. This type of interaction and interchange seems to us a new promising concept we will explore more in the future. Of course, the work presented needs to be evaluated and put to use in real work contexts. We started this in the "Ambient Agoras" project together with our partners by setting up a pilot installation at EDF in Paris. Based on the empirical results we expect from the evaluation, further work on the conceptual framework, and additional design iterations, we will test and improve our approach of designing a social architectural space using ambient information displays and mobile devices.

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