

Reclaiming Public Space

- Designing for Public Interaction with Private Devices

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ABSTRACT

Public spaces are changing from being ungoverned places for interaction to be more formalized, controlled, less interactive, and designed places aimed at fulfilling a purpose. Simultaneously, new personal mobile technology aims at providing private individual spaces in the public domain. In this paper we explore the implications of interacting in public space and how technology can be rethought to not only act as personal devices, but be the tool to reclaim the right and possibility to interact in public spaces. We introduce *information exchange*, *social support* and *regulation* as three central aspects for reclaiming public space. The PhotoSwapper application is presented as an example of a system designed to integrate pervasive technology in a public setting. The system is strongly inspired by the activities at a traditional market place. Based on the design of the application we discuss four design challenges when designing for public interaction.

Author Keywords

Interaction design, public space, mobile technology.

ACM Classification Keywords

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

INTRODUCTION

The information technology present in public spaces is increasing drastically. Billboards are replaced with digital displays, the number of portable devices has increased, wireless networks allow internet connection throughout the urban landscape, laptops are a common device in cafes and coffee bars and surveillance cameras monitor and analyze the life taking place in public spaces. All this technology

affects how life develops in the public space. Mobile phones and mp3-players are designed to be single-user devices that most often create small enclosed personal spheres within the public space. Information displays are mainly designed to distribute advertisement or notification and are, with only a few exceptions, a setup for pushing information, where people's role is to consume messages. As a large part of the public space is occupied by commercial interests new rules, regarding acceptable social behavior as well as use of technology, become regulated.

The use of technology in public space today; for either pushing information or for creating personal islands, are to some extent the opposite of the notion of public spaces as being interactive, social, democratic and self-organizing. A number of initiatives have hence worked with using technology to reclaim these aspects of the public space [1, 5, 17, 22, 26, 32]. In this paper we follow this line of work and investigate how mobile, pervasive and tangible technology can be used to design more interactive, social and self-regulated systems for use in public space.

The outset for the discussion is our work with technology in public spaces, both indoors and outdoors. To leverage the discussion we present the PhotoSwapper application. The application evolves around a shared interactive surface where pictures from mobile phones can be viewed, shared, explored and interacted with by multiple simultaneous users. Based on this work, we present a number of design concepts that address design issues relating to balancing *information push* with *information dialog*, *personal spheres* in public spaces with *social interaction* and *control* versus *self-regulated behavior* in public.

RECLAIMING PUBLIC SPACE

Public space can in general terms be described as a place open to all, free of charge. In democratic countries public space is considered a space where people can express themselves politically, e.g. through demonstrations, and live out their lives within the law. The use of public space is carried out in different ways. In some cities, urban planning forces people to use cars or other means of transportation to access public places, and some cities are

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designed to segregate people from other social classes, to minimize the “risk” of being confronted with strangers in the public. In cities not initially planned for cars, public spaces often function as an extension of the living-room, e.g. in Italy where most public life occurs in public places. As stated by [14] space is turned into place by the meaning, content and use added by people. Still, people’s views on public spaces are very different depending on e.g. social status, age, and political observance. Public space is an amazing physical and social interface between different people and a set of urban interests, both regarding consumers, suppliers, dwellers and jurisdiction. The ways these interests interrelate have been and are under continuous development and depend on spatial layout, political agendas, climate and culture of use.

However, there seems to be a development in the use of public spaces towards increased centralization and control of the use of these settings. Being engaged in private activities in public is often looked down on and offends a range of other sub-cultures, as this behavior ruins their image of the division or gradient between public and private activities. In e.g. [14] it is exemplified through the development of the bedroom since medieval times till today turning from an open social activity to a private concealed activity. A similar tendency can be seen in the development of the public space: consuming alcoholic drinks in many public places is becoming illegal, but is still legitimate on sidewalk cafes. Nevertheless, it is the same social activity, though more uncontrolled in the public setting. A similar change is happening through the arising malls, privatizing the public space, mimicking the spatial structures and the rules of public space, but in reality creating controlled semi-public spaces filtering people, opinions and activities.

The design of technology in public spaces is a highly political act that can enforce the governance as well as the centralization of public spaces, or allow more unstructured social behavior. To discuss these issues we introduce three aspects of technology design in public spaces: *Information Exchange*, *Social Support* and *Regulation*. Figure 1 presents the three design issues. The dotted circles show what technologies for public spaces are mainly designed to support today, and the full circles describe a more balanced use of technology in the public. These aspects are further presented in the following sections.

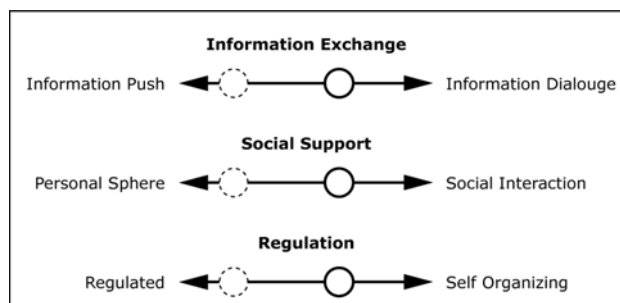


Figure 1: Design aspects for technology in public place

The Push of Information in Public Spaces

As seen with the rise in large malls there is a huge commercial interest in controlling or being present in public space due to the number of people passing through. We see many examples on how these interests compete for the attention of people present in public for maximum exposure, e.g. on Time Square where the battle between the different billboards creates a massive push of information towards the public. This strong commercial interest in pushing information to the public leaves the average person in a public place as a consumer of advertisements. This is not necessarily negative, but in line with [26] it raises the questions: Is this the only type of information exchange possible in public places? What happens to the interaction between the physical space and the people present or between the people? Is it possible to design technology in public places that is more symmetric and democratic?

Public users should be able to change this information push tendency, towards a situation where the public can expose, comment and edit elements of the public space. Thereby, the space is formed and shaped by people passing by and not only by mimicking commercial interests. This leads to the design aspect we define *Information exchange*, meaning turning the tendency from information push towards information dialogue (see Figure 1).

Public Interaction with Pervasive Technology

To understand the activities taking place Gehl [10] defines the use of public space into three categories - necessary activities, optional activities and social activities. These categories are suitable to understand the different activities and to use the public space, both concerning work and leisure activities. In this paper we mainly look at the social activities in public space, however, as Gehl’s categories are defined before the emerging pervasive and ubiquitous technologies we look at how new technology can enhance and facilitate these types of activities in public spaces.

Inspired by [14] and [6] we see place as a part of space extended with social, personal and cultural meaning. As the rules guiding public activity limit the interaction we see novel technology as a design material for reclaiming public interaction. The goal is to produce designs that encourage and support social interaction in public places without dictating any terms of use. To establish this design we take departure in the fact that a large part of physical public space is experienced visually, and therefore there is a need to move the bits in mobile devices out in public. An example is the “Blinkenlights” project [32], where people control the lights in an office building by SMS-technology.

Counting the number of digital installations and adding the number of personal devices present at any time in a public space in a modern western city the technology present is overwhelming. Wireless networks cover many city centers and people are becoming increasingly online anywhere through personal mobile devices. Though all these places and devices are connected they are not communicating with

each other. A mobile device is personal and the user has the possibility to perform private activities in public settings, e.g. sending love mails, talking on the phone or buying stocks. So far, most of these activities are not exploiting the fact that they are performed in public space, one could say that the mobile device is just extending the office space into the public without engaging in public life, and even decreases the chance of people interacting [22].

If we imagine using a mobile device for engaging in public activities this changes the device from being an introvert gadget to a gateway to a digital interaction and presence in the public space. Mobile devices are so common that almost everyone carries at least one device. By letting the mobile device be the entry point to an interactive version of the public space the interaction is not limited to the person in control of the joystick, mouse, or control box, but lets everyone interact through their mobile device. The mobile device is always present and is also a highly personal device where personal information e.g. phone numbers, messages, pictures, music, videos, games, themes, and emails are stored. It is hence an interesting gateway between the personal and public domain.

This leads to the design aspect we identify as *social support*, meaning going from the personal sphere created by personal technologies towards social interaction in public places (see Figure 1).

The Control and Governance of Public Spaces

The rules governing the behavior in public spaces need to strike a balance between the fears of exploitation versus the joy of expression. Too much control results in dull predictable public spaces whereas no restrictions can end up in pure anarchy. In [20] the virtual city of Karlskrona2 is managed by a group of people through their virtual avatar citizens. What is interesting about this experiment is that from the beginning no laws and rules exist – Karlskrona2 is a totally open virtual city platform for discussion and experiments with governance and self-organizing planning. During the experiment lots of rules evolved creating a common understanding of the life in Karlskrona2. A similar approach to public spaces is needed to make a stronger potential connection between the public space and its inhabitants, and hereby establishing the ground for place-making [14]. Beliefs that systems to a certain extent will self-organize and find a level that is not offensive to the majority of the public are crucial.

The trend is however the opposite; more and more rules are applied (no alcohol, no loud sounds, no skateboarding) as well as more surveillance through video cameras to ensure highly safe and controlled environments. Again safe environments are definitely preferable, but the point is again to strike a balance between freedom of expression and control. Here it is important to remember that any part of a public space can be misused, and introducing a new channel of expression through technology will not make it better or worse, but maybe different.

Public space has to be able to provoke, inspire and push opinions – think about singing football supporters cheering, carnivals with music and dance, or political demonstrations. All these happenings and activities might provoke and offend, but they point exactly at the important part of a public space - it is alive and partly out of control.

This leads to the design aspect we identify as *regulation*, meaning going from regulated into more self-organizing behaviour (see Figure 1). In the following section we describe an application aiming to move the design towards the full circle rather than the dotted circle in Figure 1.

THE DESIGN OF PHOTO-SWAPPER

Moving on to design, we wanted to create a design that aimed at balancing the three identified aspects in the public space discussion. We searched for an urban activity which could guide our design. We found the notion of a market place to be a strong metaphor for public space design.

An Interaction Metaphor: Market place

A market place is a highly interactive place where goods are traded and prices negotiated. Smalltalk with acquaintances and sales persons is the rule, not the exception. In many market places you can bring your own stuff and either sell it or trade it for new items. And if you have a special talent – being able to perform, draw, play chess, or pretend to be a statue - these types of activities are also highly appreciated in a market place. It is accepted to just *be there* to see what is going on, enjoy the atmosphere and hear other people's opinions.

Overall, a market place is full of atmosphere created not only by the physical space, but more by the people present. It is a place for negotiation and expression, but as a market place is relatively self-governed there is a risk of being cheated, tricked, offended or pick-pocked. The market place reflects the people there, both the good and the bad sides of life. As described earlier, place is created from public space in the user's appropriation of space adding content and meaning, in this case through the exchange of goods and the social activities this brings along [14].

In the design of an interactive tangible system for public space the market place seemed to be a good metaphor, in line with Oldenburg's 'third place'[33]. Users of the system should be able to come to the market with their goods, trade, look around, play games, talk to each other, pick up stuff and leave again.

In this paper we present the PhotoSwapper application as a prototype example, an application for viewing, talking about, playing with and sharing photos. The users can bring their mobile phones full of personal photos to the market place and use a shared public surface to upload, discuss, view and acquire photos.

The PhotoSwapper Application

The PhotoSwapper application is designed around one or several large public surfaces (see Figure 2). We call the setup with different projections or displays in public places

a marketplace. The marketplace is alone relatively uninteresting, however, the surfaces become much more interesting when someone brings a mobile device to the market place. By connecting the mobile device to the market place a new mixed system consisting of both the public system and the personal device is created. The system is not limited to one single device - everyone can connect personal devices to the system and change the topology of the system. The constellation mixes personal and public devices as well as physical and digital spaces.

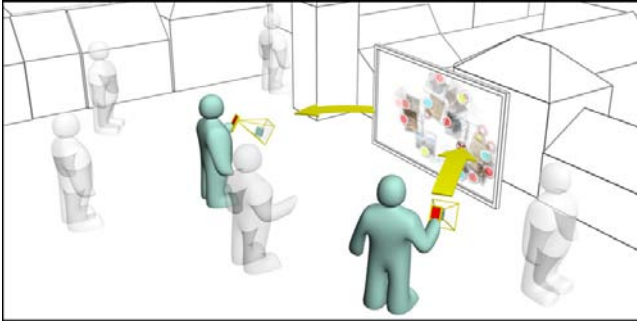


Figure 2: A market place shared display

In the Photo-Swapper application we use Bluetooth to connect the mobile devices to the public surfaces which requires people to interact with the system to be physically present. A small program on the mobile phone automatically connects to nearby surfaces when it is started. As soon as a user is connected to the surface the user is given a personal cursor which can be controlled from the mobile phone, e.g. by using the Mixis interaction technique (described in the next section). An important point is that each user is given an individual cursor which allows several users to interact with the display simultaneously, and the interaction is not limited to the person controlling the mouse.

By pressing a key on the phone a dialog box is opened where a picture from the mobile phone can be selected and uploaded to the public surface. A thumbnail of the picture is presented on the public surface together with a colored grasping point that links to the user that uploaded the picture (see Figure 3). The picture can be dragged, viewed in full resolution on another display, completely deleted or downloaded as a copy. Viewing photos in full resolution is achieved by dragging the picture to a porthole icon that moves the picture to a separate screen and shows it in full resolution. By pressing a key on the phone the picture can be deleted from the public screen or downloaded as a copy.

The described application is implemented and the shared display application runs on standard PCs with Bluetooth Dongles. A small C++ program handles the Bluetooth communication, whereas the main interface is written in Macromedia Flash. The application for the mobile devices is implemented in Symbian and runs on most high-end Nokia phones e.g. Nokia 7610, 6630, 6680.



Figure 3: Detail of the PhotoSwapper application demonstrating the individual cursors, photos and porthole.

Using Vision to Interact Through Mobile Devices

For the navigation of the individual cursor we chose to explore an alternative interaction technique called Mixis [11, 12, 13], which supports interaction in 3-dimensions, and thereby uses the mobility of the handheld private device.

In Mixis an object is selected as a reference point by taking a picture of it with the mobile device. The reference object can be anything that stands out from the surroundings by having a specific color or pattern, e.g. a jewelry, some cloth, or a handwritten symbol. If no suitable object is found, the user's face can be used as a reference point (if the mobile device is equipped with a camera pointing towards the user) [12]. Video from the camera is analyzed on the mobile device, and the vector from the mobile device to the selected feature is calculated.

This vector is then used to control the cursor on the shared display. E.g. moving the mobile device closer or further away from the tracked object can grab and release photos or interactive icons. Moving the phone left, right, forward and backward can be used to move the cursor on the shared surface. See [11, 12, 13] for more information.

This technique has previously been used in several single user applications, but it turned out to also be highly useful in multi-user applications for one or more shared displays [12]. The advantage of using Mixis is that it allows interaction in three dimensions as well as more precise control than simply pressing the key up/down/left/right.

Identifying multiple cursors

Another issue with multi-user applications is how to identify which cursor belongs to whom.

In the Photo-Swapper application the color of the chosen reference object for the Mixis interaction technique is transferred to the interface, and this color identifies the user on the public display. The personal cursor is given this color and all uploaded pictures are tagged with this color. In that way the pictures on the shared surfaces are all marked with colors taken from an object that is present or has been present in the context surrounding the interface. Relating to the public space discussion this is analogue to referring to someone in the public as "the girl with the green hat" without knowing her phone number or name.

Test Set-up and Challenges with PhotoSwapper

In a test setup displayed in Figure 4 we used two large surfaces: a floor projection and a large wall back projected screen, but other setups could be used as well, e.g. PCs, or interactive tables. The floor projection acts as the market place and provides an overview of uploaded pictures from the co-located mobile phones. The pictures can be viewed and dragged around on the floor, and a portal icon allows the pictures on the floor to be viewed on the wall display.



Figure 4: PhotoSwapper using floor and wall

While testing the application, we were able to make a small unstructured test. People involved as test persons were familiar with the floor projection as well as the back projected screen, but not with this specific application. The setup was placed at the entrance of a research institution. The results were satisfying in system performance, functionality, scaling to number of phones present, and user satisfaction. But due to the test subjects' high technical skills and general interest in technology as well as the semi-public setting these results might far from reflect the lessons learnt from deployment in real public spaces. We are currently working on staging the setup out in the real world, but are faced with a number of technical challenges, among others to get the program responsible for connecting to the market place distributed to a large number of phones. See [13] for further evaluation on Mixis.

The Potentials of PhotoSwapper

While a substantial amount of work is needed to move this application to a real public place, the prototype directly addresses the aspects introduced in the discussion on public space. This is e.g. realized by supporting social interaction where multiple users simultaneously can engage in an information dialogue through the shared market place. The governance and regulation of the content is up to the users.

Being able to upload, download copies, delete and discuss photos in public places open up for new ways of influencing the public space. PhotoSwapper builds on the mechanisms of public rules and governance. Everyone can interact through a mobile device and expose statements, happiness or anger by adding content to the shared surface. People can show their holiday pictures to the public or McDonalds can post images of their menu. The only rule is that rules are made up by the users. This openness has the potential for the users of public space to appropriate it and turn space into a meaningful place that constantly reflects

ongoing discussions, new opinions, joy, and sorrow. We imagine small games, riddles, comic strips, photo competitions, statements and more to evolve in different sub-cultures expressing the diversity of public life.

DISCUSSION

Based on our work with design in public places we suggest four design challenges that need to be considered when designing tangible, interactive, social and self-organizing systems for public spaces:

- How to move from single-user designs to multi-user designs?
- How to move from individual to social design?
- How to move from closed systems to open and extendable systems?
- How to move from regulated to self-organizing and evolving designs?

From Single-User to Multi-User Systems

There is a constant struggle to develop new applications and technologies capable of multi-user interaction on shared surfaces. In the beginning the focus was on sharing existing single-user applications across a network, such as for instance the MMM project [2]. Later the notion of Single Display Groupware (SDG) was introduced [25], and findings such as significant learning improvements [8], more motivation [15], higher levels of activity and less time off [16] are arguments supporting the development of technologies where several people can interact simultaneously on a shared surface.

Still, far too many multi-user applications are actually single user interfaces with a public display and only one or two mice or keyboards can be active at the same time [18]. As we are designing for interaction in public space we argue that the application has to support and exploit the behaviors of people in public space, e.g. multiple simultaneous activities in the same place, why we argue for a democratization of the interaction where all users are potentially able to manipulate the interface simultaneously.

PDA's and mobile phones can be used to implement simultaneous inputs. The Web Wall [9] and Digital Graffiti [5], allow users to post comments and to annotate a shared display by constructing the annotation on a PDA or mobile phone and then apply it to the system through a web-based interface. This supports democracy, but it is networked-based and not completely simultaneous. An important aspect of the market place metaphor is the possibility of exchange - these systems do not support taking information with you through your interaction device.

Other multi-user systems include capacitive surfaces or devices like the SMART DVIT [31] and the MERL DiamondTouch [7] that cope with simultaneous inputs, or active ultrasonic pens such as Mimio Virtual Ink [30]. Even more interesting is the capability of tracking and distinguishing between users actions, such as the Multi-

Light Tracking system that allows four users to interact simultaneously on a back-projected display [21]. These techniques are based on direct interaction with the display, but this one-to-one mapping is not a realistic interaction paradigm to use in public spaces, where e.g. scalability, sanitation and physical security are problems [1].

In the PhotoSwapper application multi-user interaction is supported through the Mixis interaction technique. This technique uses people's mobile phones as interaction devices, and scales to the number of users as long as they carry a mobile device.

To increase the portability of the interaction device and the physical security and sanitation of the system, we find it straight forward to use the personal devices in peoples pockets as interaction tools, for instance mobile phones and PDAs. When using the private device for public interaction with a shared display, it is important to make the user in control of what data is transferred and displayed where, so sensitive data such as name and phone number is kept private. In Photo Swapper the users' privacy is secured by using Bluetooth as communication protocol, as it only transfers the ID of the Bluetooth unit, and not phone number or name.

From Individual Design to Social Design

Nevertheless, only focusing on multi-user design is not enough to build truly public, engaging, tangible, and pervasive systems. They also need to be designed for social interaction.

In today's public spaces, technology has to some extent been incorporated into our everyday life in line with Weiser's vision of ubiquitous computing [28]. Examples of this are our use of mobile phones, and other wearable computing gadgets. The notion of ubiquitous computing also acknowledges the fact that people interact socially and behave differently in different types of situations or contexts, which are so far not really supported in today's technology.

In a number of augmented reality systems wearable computers, head-worn displays and similar technologies have moved the focus away from the interaction between users. Another approach is to put the support for social interaction first. In e.g. [4] it is not mandated to interact with co-players for the game to proceed, but it encourages social interaction to occur during the play. Since the social interaction is primarily spontaneous the game explores what Zagal et al. [29] define as stimulated social interaction. We believe that when designing for public spaces, the applications and technology need to support spontaneous social interaction, meaning interaction that occurs naturally between the participants [29]. In the notion of market places, the social interaction can take place spontaneously among the visitors of the shared market/screen, but also be mediated and stimulated by objects within it. Inspired by [19], we wish to view social

interaction as an entity in itself and not focus on the single user experience of participation.

In the PhotoSwapper application, the users' foci are not on the individual small screens on the private device, but on the shared display. Here, private material can be turned into public material, and it is possible to share information with several other users.

From Closed Systems to Extendable and Open Systems

Most digital systems in public spaces are closed controlled systems. Either they are not interactive at all, or there are some well-defined interaction sequences that are supported. To design systems for public information dialog, we argue for making systems that are more social and less restrictive.

In [27] photos taken with a mobile phone are sent as emails and then analyzed by a server to be displayed in one form or another on the public display. In this way the content on the public display will mirror the context, but the interaction is not simultaneous.

In [1, 23] visual codes are used for interacting with camera-enabled mobile phones on a large public display. The strength here is that a unique ID can be encoded in the tags; but the limitation is that the interaction technique can only be used in front of a 2D barcode, and the interaction situation is then limited in mobility and scale.

Technology and applications making use of contextual information are generally referred to as context-aware computing [24]. An example of this is location-based multi-user games, such as [3]. The game supports multi-user simultaneous gaming, but everybody is occupied with their personal device, here a modified PDA, and the interaction and action all take place individually on the screen, even though the entire city is the game board. In [4] the physical co-location of the players and objects in the world are adopted as important elements of the game mechanics. The game experience in [4] is inspired by traditional board games, and takes place in a social setting, where simultaneous participants play together in a limited physical area, a stage where players and the game meet. Still, focusing on an individual private screen is a limit in public places, and the common denominator is missing.

In PhotoSwapper we have tried to accomplish this openness by the shared display, the simultaneous interaction, and the possibility to connect and disconnect easily through your personal device.

From Regulated to Evolving Designs

A related issue is how to support open applications that are evolving through people's use.

One design principle is to support serendipitous or "come and go" interaction. The content of an application and the ongoing activities should not be affected by people joining and leaving the application and the system should support short-term interaction [1]. However as browsing a market place is an intentional activity, joining the interaction in the place requires the user to take action. Still serendipity

should be supported in the sense that the user spontaneously can join, meaning without too much effort.

In Dynamo [17], anyone can use the interface. Users attach multiple USB mice, keyboards, PDAs or laptops, and Dynamo allows users to claim areas of the surface, place and take information, display information and leave items for others. Here, public interactive surfaces are defined as inside buildings, and it is possible to rely on different external hardware gadgets physically hooked up on the computer. This is not possible to support in outdoor public spaces. The Dynamo system introduces the concept of carving out parts of the public screen estate for private use. We find this analogue to the tendency discussed earlier regarding physical public space, namely an increased privatization expanding private activities to public spaces. However, it does not comply with what we understand as acknowledging the rules and interactions of public space.

Enforcing rules is one way of controlling the use of an application, but for self-organizing systems the rules are made up as the system evolves. Within a social group a range of local tacit urban rules exist, e.g. an unwritten rule for graffiti painters stating that you are not allowed to paint over a piece that you cannot do better yourself. These rules do not necessarily comply with the law and are primarily followed by the members of the sub-community who have defined the rule implicitly or explicitly. Those kinds of rules are inspiring to the discussion of regulation, since the graffiti world actually is self-regulated in a way, even though it is invisible to people outside that community.

We do not claim that it is purely a good idea to open up for more uncontrolled interaction in public places. A controlled environment is much safer since people passing through are ensured that they do not get bothered by homeless people, racists or provoking statements, or people simply behaving in a strange manner. The control aims at making the environment pleasant, nice and secure. Interestingly, sometimes the most innovative and thought-provoking ideas appear when something offends you, or something unexpected happens. By shielding off public places from uncensored, spontaneous events (while keeping a sense of accountability) the possibilities for being provoked in a positive sense also disappear.

In PhotoSwapper, everybody is offered equal chances of displaying and controlling information. Of course, information offending other people will certainly be uploaded, just like graffiti, but as the system is self-regulated, people who get offended can easily remove the offending material.

CONCLUSION

In this paper we claim that many public places, though still publicly available, are restricted in their use by a number of rules, stating how different groups of people are allowed to behave, and that these spaces are designed as being places for information or advertisement and not for personal expression. We further point to that personal technology,

especially represented by the mobile phone, is being used extensively as a private anti-social device in public places. In this paper we ask the question if pervasive and mobile technology can be used the other way around - to enhance interaction in public places while still being a personal device - to be a facilitator for bringing interaction back into public spaces.

We have introduced the metaphor of the market place to guide the discussion of social interaction in public spaces and we have identified a number of central design issues relating to balancing information push with information dialog, personal spheres in public spaces with social interaction and control versus self-regulated behavior in the public. All of the issues relate to how digital technologies can play a role in a more democratized, sporadic, and social experience with digital technology in public spaces.

The PhotoSwapper application represents a project aiming to address some of the issues while not being able to embrace all of them. Using interaction technologies such as Mixis we demonstrate how it is possible to overcome hindrances for social interaction. The PhotoSwapper application shows how multiple users can participate on "equal terms". The interaction is not controlled by the user with the mouse, but by everyone with a mobile phone acknowledging basic rules of public living.

In the paper we have focused on identifying current problems with public spaces, surveyed and discussed how mobile and pervasive technology can be used to facilitate interaction in public spaces, as well as presented a photo-sharing system based on the market place metaphor. We hope that the presented discussions can be used to move the focus from designing private mobile devices to designing new interesting places where mobile devices are integrated to support social interaction.

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REFERENCES

1. Ballagas, R., Rohs, M., Sheridan, J.G., Borchers, J. "BYOD: Bring Your Own Device". Workshop proceedings of Ubiquitous Display Environments at Ubicomp 2004, September 7-10 Nottingham, UK.
2. Bier, E. A., sFreeman, S. 1991. MMM: A User Interface Architecture for Shared Editors on a Single Screen. In Proceedings of User Interface and Software Technology (UIST 91) ACM Press, pp. 79-86.
3. Benford, S., Crabtree, A., Flintham, M., Drozd, A., Anastasi, R., Paxton, M., Tandavanitj, N., Adams, M. Row Farr, J. Can You See Me Now? In ACM Transactions on Computer-Human Interaction, ACM Press, 2005.
4. Björk, S., Falk, J., Hansson, R., Ljungstrand, P. Pirates! - Using the Physical World as a Game Board. Paper at

- Interact 2001, IFIP TC.13 Conference on Human-Computer Interaction, July 9-13, Tokyo, Japan.
5. Carter, S., Churchill, E., Denoue, L., Helfman, J., Nelson, J. Digital graffiti: public annotation of multimedia content. In *Extended abstracts of the 2004 conference on Human factors and computing systems*, pages 1207–1210. ACM Press, 2004.
 6. Ciolfi, L. *Situating 'Place' in Interaction Design: Enhancing the User Experience in Interactive Environments*. Ph.D. Thesis, University of Limerick, Dept. of Computer Science and Information Systems, College of Informatics and Electronics, July 2004.
 7. Dietz, P.H.; Leigh, D.L., "DiamondTouch: A Multi-User Touch Technology", *ACM Symposium on User Interface Software and Technology (UIST'01)*, pp. 219-226, 2001.
 8. Druin, A., Stewart, J., Proft, D., Bederson, B., & Hollan, J. KidPad: A design collaboration between children, technologists and educators. In *Proceedings of CHI, 1997*, ACM, pp. 463-470.
 9. Ferscha, A. Vogl, S. *Pervasive Web Access via Public Communication Walls*. In *Proceedings of the First International Conference on Pervasive Computing*, pages 84–97, Zurich, August 2002. Springer-Verlag.
 10. Gehl, J., *LIFE BETWEEN BUILDINGS - Using Public Space*, Van Nostrand Reinhold, New York, 1987
 11. Hansen, TR, Eriksson, E, Lykke-Olesen, A. *Mixed Interaction Space – Designing for Camera Based Interaction with Mobile Devices*. In *Proceedings of CHI 2005*, ACM Press.
 12. Hansen, TR, Eriksson, E, Lykke-Olesen, A. *Use Your Head – Exploring Face Tracking for Mobile Interaction*. In *Proceedings of CHI 2006*, ACM Press, 2006.
 13. Hansen, TR, Eriksson, E, Lykke-Olesen, A. *Mixed Interaction Spaces – expanding the interaction space with mobile devices*. In *proceedings of British HCI 2005*, Edinburgh, UK.
 14. Harrison, S., Dourish, P. *Re-Place-ing Space: The Roles of Place and Space in Collaborative Systems*. In *Proceedings of CSCW, 1996*. ACM. USA.
 15. Inkpen, K., Booth, K.S., Gribble, S.D. and Klawe, M. 1995. *Playing together beats playing apart, especially for girls*. In *Proceedings of CSCL'95*
 16. Inkpen, K.M., Ho-Ching, W., Kuederle, O., Scott, S.D. Shoemaker, G.B.D. 1999. "This is fun! We're all best friends and we're all playing": Supporting children's synchronous collaboration. In *Proceedings of CSCL 99*.
 17. Izadi, S., Brignull, H., Rodden, T., Rogers, Y., Underwood, M. 2003. *Dynamo: a public interactive surface supporting the cooperative sharing and exchange of media*. In *Proceedings of Symposium on User interface Software and Technology, UIST '03*. ACM Press, New York, NY, 159-168.
 18. Johanson, B., Hutchins, G., Winograd, T., Stone, M. 2002. *PointRight: experience with flexible input redirection in interactive workspaces*. In *Proceedings of Symposium on User interface Software and Technology, UIST '02*. ACM Press, New York, NY.
 19. Ludvigsen, M. (2005) *Designing for Social Use in Public Places – a Conceptual Framework of Social Interaction*, *Proceedings of DPPI 05, Designing Pleasuable Products and Interfaces Conference on 24-27 October, Eindhoven, The Netherlands*.
 20. Nielsen, R. *Collaborative Spaces: Inhabiting Virtual 3D worlds*. In: *Virtual Space: The Spatiality of Virtual Inhabited 3D Worlds*. Ed. Lars Qvortrup., Springer-Verlag UK, 2002. p 171 - 189
 21. Nielsen, J. Grønbaek, K. *MultiLightTracker: Vision based simultaneous multi object tracking on semi-transparent surfaces*. In *proceedings of the Conference on Computer Vision Theory and Applications (VISAPP 2006)*, Feb, 2006 Setúbal, Portugal.
 22. Paulos, E, Goodman, E. *The familiar stranger: anxiety, comfort, and play in public places*. In *Proceedings of CHI '04*. ACM Press, New York, NY, 223-230.
 23. Rohs, M., *Real-World Interaction with Camera-Phones, 2nd International Symposium on Ubiquitous Computing Systems (UCS 2004)*, 2004
 24. Schilit, B., Adams, N., Want, R. *Context-aware Computing Applications*. *Proceedings 1st Workshop on Mobile Computing Systems and Applications (MCSA '94)*, pp. 85-90, IEEE Press.
 25. Stewart, J., Bederson, B., Druin, A. *Single Display Groupware: A Model for Co-present Collaboration*. In *Proceedings of CHI'99*, (1999), 286-293
 26. Struppek, M. *Urban Screens - The Urbane Potential of Public Screens for Interaction*. In: *intelligent agent Vol. 6 No. 2, Special Issue: ISEA2006 Symposium, 2006*
 27. Thoreson, J. *PhotoPhone Entertainment*. In *Proceedings of CHI 2003*, ACM Press, 2003.
 28. Weiser, M., *The computer for the twenty-first century*. *Scientific American*, 94-100, September 1991.
 29. Zagal, J.P., Nussbaum, M., Rosas, R. *A Model to Support the Design of MultiPlayer Games*. *Presence: Teleoperators and Virtual Environments, Vol.9, No. 5*, pp. 448-462, MIT Press.
 30. <http://www.mimio.com>. Last visited 17.10.2006
 31. <http://www.smarttech.com>. Last visited 17.10.2006
 32. <http://blinkenlights.de/>. Last visited: 17.10.2006
 33. <http://www.pps.org/info/placemakingtools/placemakers/roldenburg>. Last visited: 17.10.2006