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Curiosity Objects: Using Curiosity to Overcome Interaction Blindness

Abstract
Although there has been a widespread proliferation of large interactive public displays, studies have demonstrated that many of these interactive displays suffer from interaction blindness, which is the inability of passers-by to recognize and explore the interactive capabilities of those surfaces. In this position paper, we put forward the notion of curiosity objects, curiosity-provoking artifacts designed according to five fundamental principles of curiosity. Curiosity objects exploit the curiosity of passers-by to unveil the interactive capabilities of public displays thereby overcoming interaction blindness. Our initial experiment confirmed the interaction blindness problem and demonstrates that introducing a curiosity object into a public space containing an interactive display (i) significantly increases the interactivity with the display and (ii) invokes changes in movement in the spaces surrounding the interactive display.

Author Keywords
display blindness, interaction blindness, curiosity object, situated public displays

ACM Classification Keywords
H.5.2 [Information interfaces and presentation]: Input devices and strategies
**Introduction**

Public displays are increasingly introduced in urban spaces around the world to display information (e.g. in train stations or airports), advertisement (e.g. in shopping malls) or video and television [2]. With the more recent introduction of touch technology, the traditionally unidirectional communication of these public displays have been altered to a two-way communication that allows public interaction. Despite the ubiquitous deployment of these interactive displays, several longitudinal studies [5, 9] show that these types of urban displays suffer from two fundamental problems, display- and interaction blindness.

**Display Blindness** Because most large displays are placed in urban spaces specifically for advertisement and publicity purposes, they elicit display blindness [7]: passers-by choose to ignore or only quickly glance these display as the information on the display is perceived as unimportant or irrelevant [5].

**Interaction Blindness** Since most public screens look like non-interactive displays, the interactivity of the displays are often not visible to the user [9]. This problem is potentially even amplified in cases were public displays switch between publicity and interactive mode.

Explicit interaction invitations, e.g. a "touch me" message on the screen, have been used as an approach to overcome interaction blindness. This approach however suffers from two major drawbacks: first they require screen estate which is not feasible in many advertisement scenarios. Second, studies have shown that displaying invitations alone are simply ineffective [9] as the public keeps ignoring them. The integration of personal mobile devices, such as phones or tablets, into the public interaction is an other approach [4]. Their use however introduce one major drawback: they require active interruption of the user to overcome the blindness problem. Other approaches include context-aware systems using location tracking or gaze activation [6].

In this position paper, we put forward the notion of curiosity objects, curiosity-provoking artifacts designed according to five fundamental principles of curiosity and explore how curiosity objects can decrease the display/interaction blindness problem.

**Curiosity as Motivator**

Curiosity is one of the important driving factors of human behaviour as it is used as mechanism to make sense of the world [1]. It is stimulated by external conflicting stimuli such as complexity, novelty, and surprise and influences how people interact with physical objects. Summarized, perceptual curiosity is the attention and interest given to a novel perceptual stimulation that motivates sensory and visual inspection.

Based on this theoretical work, Tieben et al. [10] propose five properties: (i) novelty, (ii) complexity, (iii) uncertainty, (iv) conflict and (v) partial exposure, as fundamental principles to design for curiosity. Their description of the curiosity process is composed of different phases that are directly influenced by these principles. At first, humans encounter a curious situation driven by the novelty, uncertainty and conflict of that particular situation. After this initialization phase, they explore and discover the situation influenced by the complexity and exposure. The latter two thus determine the lasting effect of the exploration that resulted from the curiosity.

The importance of curiosity as an intrinsic motivation for interactive technology has also been recognized by Müllер.
et al. [6]. Their design space analysis reveals that curiosity "belongs to the most important characteristics of intrinsically motivating environments" and describe how well crafted interaction can induce curiosity and motivate people to engage into interaction with large displays.

Inspired and motivated by this previous work, we propose the notion of a curiosity object, an object, informed by principles of Tieben et al. [10], that is used as a mediator between the public and interactive displays in an effort to remove the display and interaction blindness. Because of its curious character, it has a honey pot effect as it attracts people based on its natural properties and affordances. When people interact with the device, the curiosity object reveals the interactive possibilities of the displays, thereby removing the display and interaction blindness.

Figure 1: The positioning of the display and curiosity object creates four zones.

The positioning of both the public interactive display and curiosity object creates a number of zones (Figure 1) [8]. The primary interaction zone is directly in front of the interactive display allowing a person to physically touch the screen. The secondary interaction zone refers to the space surrounding the curiosity object. People in this space are able to touch and interact with the object. The engagement zone is the surrounding space in which people can observe the content of the display. Finally, the ambient zone refers to the physical space in which people are able to observe the displays presence but not its content.

**Experimental Setup**

To explore the effects of a curiosity object on the visibility of the interactive possibilities of an interactive display, we conducted a two-day experiment. The purpose of this exploratory experiment is twofold: (i) create a baseline that provides further evidence for the existence of the display/interaction blindness problem and (ii) explore the short-term effects of a curiosity object compared to this baseline.

In this paper we reconceptualize an artifact known as the "Worlds Most Useless machine" (WMU machine) to a curiosity object. The machine was invented by Claude Shannon and initially described by Arthur C. Clarke [3]. The machine is a small wooden casket, the size of a cigar box, that only contains a switch at one side of the top plane, and a servo actuated arm, that remains hidden inside the device enclosure. Once a user toggles the switch, the machine actuates its arm, pushing the lid open, to restore the state of the switch to the off-position, effectively undoing the users action and rendering the machine useless. The "Worlds Most Useless machine" fulfils all five curiosity qualities.

Our system (front page figure) was deployed in two variants. First, the baseline-variant consists of a display and a Microsoft Kinect depth-sensor used to gather movement data. The second variant is the curiosity variant which extends the baseline-version with a curiosity object (in this case the "worlds most useless machine"). In both setups, the Microsoft Kinect is used to reset the experiment when there is no user within a 3 meter range.
Resetting the experiment causes the WMU machine to reset the switch state if necessary.

In both variants the interactive touch screen runs in two modes: (i) poster mode, in which it would show advertisement-like information and (ii) interactive mode, in which users can draw picture using touch interaction. In the baseline the system switches from poster to interactive mode by touching the screen. Whereas in the curiosity variant, the display goes into interactive mode when a user actuates the WMU machine switch or touches the screen. In case a user toggles the WMU machine switch but does not touch the screen, the screen will go to poster mode after one minute.

We observed approximately 1600 participants (861 passer-bys on day 1 and 825 on day 2) pass by the display. During the baseline variant (day 1), not a single person interacted with the display whereas during the curiosity object variant (day 2) 41 interaction instances (activation of interactive mode was logged by the system) involving 81 people occurred. Figure 2 provides a overview of the types of interactions that were observed over the course of one day.

Discussion
Zone movement
There was an increase in interactivity in the system variant that contained the curiosity object. Many participants were attracted to the curiosity object and tried to interact with it. In total 81 people interacted individually or in a group with the setup resulting in 78 sketches. Analysis of the video recordings in relation to the aforementioned zones showed 5 distinct patterns (Figure 2) in which people interacted with both the curiosity object and the interactive display. 76% of the participants that were attracted by the curiosity object (secondary interaction) also moved to the screen to create a sketch (primary interaction). This movement from the curiosity object to the primary screen is one of the main observations that confirms the ability of the curiosity object to (partially) remove the display and interaction blindness. However, in 24% of the cases, participants would interact only with the curiosity object, ignoring the interactive display. These were primarily passers-by that simply flipped the switch without waiting for a response or people who simply did not find the screen interesting enough. A side effect of people interacting with the main display (after using the curiosity object) is that some passers-by noticed the emerging or ongoing interaction, and are directly attracted by the display without even noticing the curiosity object. This shows that the curiosity level of the object is balanced enough to start the exposure of the interactivity of the display but not to suck up the attention of the main interaction actors and passers-by. The primary interaction thus produces social effects that draws other people to the display.

The interactive display and curiosity object is devised to reset after interaction actors walk away from the screen. The curiosity object shows a visual cue of reset (in this case, the automatic reset of the toggle switch) which can be noticed by passers-by. We observed several instances where the visual reset of the curiosity object would draw attention of people who would then again start interaction with the setup as mentioned in the first two patterns. During one instance, the social effect described in pattern b and c (Figure 2) snowballed into a large group that would form around the curiosity object and the interactive screen (Figure 2 e). During this instance, the social effect was amplified because of the presence of a crowd.

Figure 2: Different zone movements caused by the curiosity object.
Curiosity

Although the device is known in certain engineering and computer science circles, it is very novel for most common people. The placement of a wooden box in the middle of a public space draws attention simply because of the illogical relation between the box and the environment. The shape of the box and the affordance of the switch exhibits a certain degree of complexity, but not so much that the machine would be puzzling. However, people can interpret the function of the device in many different ways, which leads to exploration to expose its functionality. The level of complexity and novelty thus arouses exploration. The shape and the switch it contains result in uncertainty as the result of actuating the switch is not clear beforehand. The action of flipping the switch might be surprising and because of uncertainty, doubt and predictive behaviour is shown.

One of the key features of a curiosity object is the ability to introduce conflict. Because of the uncertainty and novelty, the device can violate the (sometimes false) expectations of the users while still exploiting the affordances. This allows the curiosity object to be connected to another device or object. In the case of the WMU, the expected result is that flipping the switch changes the state of the box, although it actually turns on the interactive mode of the screen. One of the fundamental properties of the curiosity object is the partial exposure of information to users. As users flip the switch additional information on the nature of the public space is presented to the user, who can then choose to react to this event.

Acknowledgements

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References

Evaluating Community Response to Content on Public Displays

Abstract
This paper presents the results towards the evaluation of content on public displays, and in particular of the impact on its 'users'. In an attempt to gather the reactions from local citizens on an existing urban display, we deployed four different research methods, i.e. contextual interviews, card ranking, interactive content demonstration and postcards. Our analysis has identified a wide range of methodological issues, including social barriers, time constraints, shallow responses and the difficulty in eliciting on-site creative thinking. As a potential solution to overcome these findings, we describe the initial results of a pilot case study involving a radically new approach, in which we allowed citizens to experience content creation and curation on a public display first-hand.

Author Keywords
Public display; urban display; smart city; evaluation study; participation.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Recent technological advances and increased affordability have encouraged various local authorities
to deploy public displays in strategic locations such as tourist hotspots, commuter hubs and other points of convergence. These displays generally aim to extend existing local communication platforms like newspapers, leaflets or posters, and even have the potential for stimulating social interaction [1; 2] or positively impact cultural life (e.g. [6]).

Most current research endeavors in the domain of public display focuses on the issues of usability and noticeability [4; 5], the variety of possible content types [3; 7; 10] and supported modes of interaction [8; 9]. However, we believe that most public displays do not yet fully exploit their true ‘public’ potential, as they lack any obvious mechanism that allows citizens to impact the content to be displayed. Accordingly, to the best of our knowledge, still little is known about the preferences of citizens towards public display content, and to what extent the surrounding social fabric can benefit from content that is publicly-agreed upon. This phenomenon might be explained by the relatively limited technical capabilities of currently available public displays, and a general lack of attention towards integrating public displays within their surrounding social context [12].

In this paper, we introduce our first results towards understanding the preferences of the local population about what ‘should be shown’ on urban displays, and how they perceive the relevance of the content that is actually being displayed. This research covers the technological aspects (what is possible within the technical boundaries of current public displays), contextual aspects (how to evaluate the suitability of content across various social contexts) and creative aspects (how to acquire original feedback from locals).

Public Opinion: What people ‘want’
We have gathered feedback from citizens on an existing public display in Leuven, a medium-sized Flemish city, through the deployment of 4 evaluation methods that each focused on a particular question: 1) how people consider the display to be integrated in the surrounding environment (i.e. contextual interviews); 2) what people want to see on the display (i.e. card ranking); 3) how the public reacts to prototypes of content (i.e. interactive content proposals); and 4) what creative insights can be triggered from people by letting them draw or describe content (i.e. postcards).

Contextual interviews. The response from citizens was gathered during a semi-structured interview session, based on a predefined list of questions revolving around the relation of the person to the city (e.g. resident, commuter), their planned itinerary (e.g. regular pattern, specific goals), and their appreciation of the public display (e.g. perception of content). After interviews were concluded, affinity diagramming helped to organize the responses and yield insights.

Added value. Situating the interviews within the direct vicinity of the display allowed participants to quickly relate to the research subject, observe the context and form useful opinions.

Issue. Motivating individuals to participate tended to be difficult, as most citizens perceived the researchers as street vendors or pollsters. This hints at an underlying fear of social embarrassment. People that expressed interest to participate were often constrained in time, which prohibited more detailed questions or poll the personal motivations or argumentations behind the answers given.
Card ranking. To enable the acquisition of more qualitative responses, the method of card sorting was reshaped for the urban environment context. Participants were offered an incentive (e.g. a free coffee) to select and rank three keywords from a list of 30 given keywords, according to what they considered the most appropriate to be shown on the public display. The keyword list was based on results from contextual interviews and covered 18 areas of interest such as wayfinding, commercials, messaging or culture.

Added value. The ranking of cards happened in an indoor environment (i.e. a nearby café), encouraging participants to engage with the subject for a longer period of time (approximately 20 minutes). In-depth information about the motivation or argumentation of specific preferences could be acquired.

Issue. Convincing people to participate in the card ranking proved very challenging, as participants are required to follow researchers to a different location, and invest a considerable amount of time.

Interactive proposals. We developed an alternative form of public inquiry, now using the public display itself as a mediator for motivating people to participate. This also provided the direct context on which participants should form an opinion. We utilized a tablet computer with a 3G connection to dynamically switch between possible content alternatives on the public display, in real-time during interviews (see Figure 2). In addition to providing a playful, visual experience, showing content prototypes directly on the display provided participants with an immediate impression of any implications it might bring.

Added value. People were easier to motivate to participate in the study, as they immediately perceived the interactive connection between the tablet computer and the public display; lifting the suspicion researchers were in fact street vendors.

Issue. Participants tended to solely endorse or dislike content by giving one-word replies (e.g. yes / no), even when elaboration was explicitly encouraged.
In order to overcome the issue of actively motivating passers-by to contribute, we introduced a participation method that could be observed from a distance. Input from passers-by was acquired using postcards that were attached to the base of the display by way of cables and clothespins. The display itself showed a continuously changing list of topics, preceded by "On this display I want …", while a prompt encouraged people to submit a postcard, or evaluate the ones that were already attached (see Figure 3).

Added value. By not actively approaching people, fear of social embarrassment was lifted. The clearly visible postcard collection motivated people to come closer and read, increasing the chance they would participate.

Issue. In contrast to previous methods, a substantial amount of people actively participated. However, people tended to bring up ideas already known to researchers and content managers. Additionally, most postcards contained written ideas instead of more imaginary sketched content proposals.

Overall, we observed that results were underwhelming. Across all methods, some participants indicated they never observed the public display before or did not appreciate the technology for societal (e.g. excess of commercial advertising) or architectural reasons (e.g. insufficiently integrated in the environment). Also, contextual interviews, card ranking and interactive proposals did not elicit citizens to be creative, often resulting in content proposals that do not contain an intrinsic quality or are not innovative. Most common content suggestions across all methods include video clips (e.g. live sports), local information (e.g. tourist hotspots, locations that are off the beaten track) or cultural announcements (e.g. planned music concerts). The postcards method attracted participants more easily, likely because the postcards, the cables and clothespins themselves served as attraction poles. Additionally, people not willing to suggest ideas could still rate proposals that were previously submitted.

Public Impact: How communities respond
The mentioned issues of involving passers-by in reflecting on public display content, motivated us to consider working towards an ‘embedded’ evaluation methodology in which citizens could experience content creation first-hand. This led to the installation of a small public display behind the street-side window of a normal residential house. By rescaling the display to the scale of a city street and by making ownership and authorship visible to members of the community, we believe it may lower the barrier for residents to publish messages on such displays, and facilitate possibilities to gather responses from nearby residents. Accordingly, we recently ran a 7-day pilot case study in the city of Leuven with a display installation that allowed text messages of up to 80 characters to be shown.
As residents can publish messages to the display at any time, they also have the opportunity to think about content at their own pace. In contrast to the previously applied methods, this allows for more spontaneous input without an explicit need to be prompted. Also, the private context of a residence may yield a stronger sense of responsibility of the residents towards the display (i.e., its placement in the house) and its content (i.e., quality control by the household).

During the experiment, the participating household published 121 messages. These were analyzed and categorized inspired by methods used in Grounded Theory [11] to uncover main content categories: the large majority of messages (n=68) were meant to interact with or inspire neighbors and passers-by (e.g., “Hello R., how are you today?”), 28 were observations about the weather or current events (e.g., “It’s so cold outside!”), 21 offered some form of self-disclosure (e.g., “Would you also love pancakes with a hot chocolate?”), and 2 were humorous and did not explicitly aim for response (e.g., “Ceci n’est pas un message”, French for “This is not a message”). The remaining 2 messages were classified as erroneous (e.g., containing spelling errors but quickly replaced by a revised one). Our analysis indicates that most published messages were relevant on a micro-level (e.g., events within the family) or situated within the immediate environment (e.g., interacting with neighbors). This contrasts to the results from previous methods, where content proposals were mostly approached from a macro-level point of view (e.g., general announcements, without personally addressing groups of people).

We believe these observations prove promising to be applied in the context of large public displays, by analyzing published content along with reactions by content creators and the larger community. This may result in clearer insights to be formulated about preferences and expectations towards public displays, and the impact such displays have on the environment.

References
Community Beat: Revealing the Hidden Rhythms of a Neighbourhood

Abstract
We live our lives in a world of hidden rhythms, but many of these rhythms were socially constructed many years ago and may no longer be best serving us. In this paper we present our concept for an interactive public display that aims to make people aware of some of these hidden rhythms and help us question how we make use of our time. We raise a number of design decisions to bring this concept to reality, and a number of research questions arising out of it.

Author Keywords
Life rhythms; reflection; public display; interactive display; crowdsourcing

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Routines, rituals, habits, rhythms – they regulate our everyday behaviour and in many ways make it easier for us to function in a complex world. I take exactly the same route to work each day, cross the road at the same set of traffic lights, choose the same side street to walk along. This removes the need for me to think about these things and frees up my time to think about something else as I make my way to work. Sometimes I arrive and can barely remember how I got there. But
I worked out this route over a year ago. What if some things have changed? If there is a crossing in a different place, a new coffee shop has opened up on the route or in the summer it is possible to walk across the park that was impassable in the winter when I first started to work out the route? I walked to work with a colleague a couple of weeks ago and was taken her route. I found a crossing that was easier to use and my new walk to work is now slightly altered. In a way it doesn't matter. But how many opportunities in life do we miss out on because we have established a routine which we no longer even notice or question? Scaling up, families, communities, cities, countries all make use of rhythms and rituals – they regulate the whole of our lives, and in the same way I had stopped noticing the way in which I walked to work until taken another way by someone else, many of the rhythms of our society are equally hidden [2]. Most of us go to work at the same time, have lunch around the same time, schedule activities in units of hours and take the weekend off. These things are so natural to us that we only question them when something forces us to work outside of the established rhythms. Of course, our natural biological rhythms (waking with the light and sleeping in the dark hours of the day, the need to eat throughout the day to sustain ourselves etc.) have dictated many of these rhythms – and everyone in society knowing and understanding the rhythms makes it easier for everyone to get along. But it also creates problems: e.g. rush hour, falling asleep in meetings, struggling to work and fit in looking after small children or spending time with family. Perhaps some of these rhythms are out of date too? Things have changed, and we’re no longer making the best use of our time given the world we currently live in - a world becoming increasingly busy, where there are more and more constraints on all sorts of resources including fuel, space, travel etc. And a world in which technology makes it possible to work and live our lives in ways inconceivable even 20 or 30 years ago. If we could learn to see these rhythms we might be able to reflect on and question them, and think about how we might do things differently. There are many ways in which we could use technology to prompt this reflection (see [1]). Recording and re-representing these rhythms could help people look at them in a new light, or from a different perspective, perhaps becoming aware of them for the first time in years. Discussing with others, seeing what others do and sharing our experiences with them can also prompt reflection, raising awareness of what we do and of alternate ways of doing things.

Concept
Our concept is for an interactive community display which allows people to compare the movements around and rhythms of their community to their own. The display would be situated in a public space, somewhere in the heart of the community where people could see it as they wander past everyday, but that allows a few people to gather and spend time looking at it. Various sensors around the community would monitor people’s movement through and use of space in various ways (e.g. shop doors or park gates opening, benches sat on, bus stops waited at, library books checked out, cups of coffee sold, busyness of train platforms, traffic flow etc. - perhaps not unlike the city dashboard project [3], and people’s paths travelled through the space crowdsourced via their mobile phones - in a manner similar to various exercise apps e.g. Strava [4]). This data would be used to build up a representation of activity in and around the community, and movement through it, at various times of the day.
It might also display some of the facts and figures used to build up the picture (e.g. how many library books checked out, how many coffees sold). Passers by would be able to interact with the display in order to see how activity changes throughout the day, week, month or year. For those choosing to use it, a smartphone app will allow them to see how their own behaviour compares to that of others, and a website might allow people access to some of the numbers which make up the overall picture of activity level.

**Design Decisions**

At the moment, this really is just a concept, a pie in the sky thought experiment about a community display we would be interested in building. But it is a starting point to our thinking about all the issues involved in turning such a concept into reality. There are many design decisions that would have to be made – at the very broadest level, this includes: where to place such a display, what to measure and record in the community and how to represent it, how do people interact with the system - are they able to interact directly with the public situated display, only online or via a mobile app, or only by affecting the data through their own movements. How do we visualise this data in a way that makes sense to people but does not compromise privacy, in particular how to represent change over time?

**Research Questions**

Following from this, there are a number of research questions that we might want to ask: what might revealing these patterns get people to think about, what behaviours might we change, is there any value in this, how do we understand how people have been changed by the display (or if they have)? This list goes on.

**Conclusion**

In this paper we have suggested the value in providing people with an opportunity to question some of the rhythms of their own lives and of the society around them to consider if there are different ways we could manage our lives. We presented the concept for a public interactive display which shows people the movements around and rhythms of their community in order for them to question them and compare to their own. This display is currently only a concept, and we listed some of the design decisions and research questions we would have to address. We hope our participation in the workshop will be instrumental in moving this concept forward.

**References**


Situated Displays vs. Municipal WiFi: Comparing the Interactivity of Two Public Infrastructures

Abstract
We compare the interactive experiences of two public infrastructures — situated displays and a municipal wireless network — using a conceptual framework of place, experience and embodiment. Using the framework as a point of reference, we can begin to address some inherent design issues in these technologies. Consequently, we argue that urban technologies which take into account their environment and leave room for creativity, add and support existing meaningful experiences in the city.

Author Keywords
Place; embodiment; interaction; public displays; WiFi.

ACM Classification Keywords
K.4.0 Computer and Society; General

Introduction
The Open UBI Oulu initiative has deployed rich pervasive computing infrastructure in downtown Oulu, Finland. The objective is to turn Oulu into a civic laboratory for a long-term large-scale study of future computing systems “in the wild”. The infrastructure facilitates longitudinal provisioning of services to the general public in an authentic urban setting, thus
establishing the technical and cultural readiness and the critical mass of real users needed to evaluate a system or service (un)successful. [8] In this paper we compare interaction offered by two particular public infrastructures, namely situated displays and a municipal wireless network. Both infrastructures have been openly available to the general public for several years. Their contrasting characteristics provide an intriguing starting premise for a comparison that is conducted with a conceptual framework of place, experience and embodiment. From the outcome of the comparison we synthesize future research directions and design guidelines for such public infrastructures.

**UBI Hotspots** are a network of 17 situated displays deployed at pivotal indoor and outdoor locations around Oulu since 2009. In terms of interaction a hotspot is in either passive broadcast (digital signage) or interactive mode. In passive broadcast mode, the whole screen is allocated to the UBI-channel showing a customizable playlist. When the overhead cameras detect a face or someone touches the screen, the hotspot changes to an interactive mode, where the screen is divided between the UBI-channel and a customizable UBI-portal. The current version of the portal contains 25 distinct interactive services provided by us, the City of Oulu, businesses, NGOs and creative communities. The portal is identical in each hotspot. Currently, the hotspots attract on average ~1500 clicks per screen monthly, but variations between hotspots at different locations can be very large. The six most popular services include four games, the Oulu Today page provided by a local newspaper, and the City of Oulu website.

The **panOULU WLAN** (panOULU from now on) is a municipal WiFi network deployed around Oulu since 2003. It currently has ~1400 IEEE 802.11 WLAN APs (access points) that provide open (no registration or authentication), free (no payment) and unrestricted (no limitations) wireless Internet access to the general public. While downtown Oulu is blanketed with a uniform coverage, elsewhere the network is deployed in a hotspot manner. For example, most public municipal premises have panOULU coverage. The connection is provided “as is” without any quality of service or security assurances. Currently, the network is used by ~50000 unique devices every month, and the number has doubled in the past 2 years, showing a steep growth trend in usage. (Fig. 1)

**Conceptual framework**
In the study of technologies situated “in the wild”, there has been much talk about the need to understand the physical reality where these technologies are deployed [16], and rightfully so. However, what is often missing from this demand is the understanding that the physical reality and our social and cultural practices are in a dynamic relationship where one influences the other. It is impossible to talk about the physical affordances of a space without discussing the practices related to that location, as these necessarily affect our decisions and imaginations about how to use that space. Thus we consider the concept of place central, as it enables us to think about situated technologies and interactions in a more holistic manner.

According to Agnew [1], all places have three attributes: a location, a locale and a sense of place. Location refers to specific coordinates at a given point in time. In the case of Oulu, we can say it is located at 65°01′N 025°28′E, which makes it a northern European city with unique conditions. Secondly, a place must
have a *locale*, a materiality which serves as the setting for social interaction, encompassing, e.g., the size and shape of things and their material properties. Thirdly, we create places out of spaces by attributing meanings to them, which Agnew refers to as a *sense of place*. This sense of place is actively produced by people in their everyday lives through their experiences as embodied individuals.

To understand individuals’ experiences connected to these technologies, we apply de Certeau’s [4] theory about the *practice of everyday life*. According to him, we can make a distinction between *strategies* and *tactics* concerning technologies’ functions. Institutions and structures of power have their own strategies, e.g., (political) agendas, visions, and goals when designing and implementing new technologies in the city space. However, “ordinary people” do not necessarily adopt or even know these official versions about technologies’ functions. Instead, they have a range of tactics when using it; they interpret it through their actions. Through their everyday practices people create meanings for things. Dourish *et al* call this aspect “the active production of urban living”, and argue it offers “opportunities to reconsider the goals and methods of urban computing” [5, p. 12]. We consider individuals’ experiences related to urbancomp technologies profoundly *embodied*, and situated in time, place, and the co-presence of other people. Place and experience are thus inherently connected through embodiment. (Fig. 2) Through these concepts, we can examine the physical appearance, digital content and the interactive experiences provided by situated technologies.

**Comparison**

All the previously mentioned aspects relating to place, practices, and technologies are a part of a dynamic whole. Next, we will examine embodied interaction taking place within this whole by examining the intersections of *location, locale* and *sense of place* with *strategies* and *tactics*; and, based on this, cast a critical eye on the two chosen technologies.

Location-wise, a display requires the people who wish to use them to be physically present in a certain spot in a public place; a feature already identified as a challenge [13, p. 59]. Things around the displays, however, are in a constant state of flux: e.g., the weather, the sun, and the flow of people and vehicles. This has an unavoidable effect on users’ experiences of bodily and psychological comfort. In comparison, the panOULU wireless network is a much more ethereal presence by design (or strategy), yet tied to the physical location where it is available. This location, however, is larger in diameter. In the city centre, the panOULU AP’s form a night full coverage, giving its users the opportunity to choose where they would like to use it and how they want to position their bodies.

In their material locale, the displays’ physical attributes bring a layer of difficulty for interaction. The two-dimensional screens necessarily dictate the shape of

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1 We appreciate that the term *appropriation*, which e.g., Dix [3] has used to mean users’ adaptation and adoption of technology in ways designers never planned for, is well-established in the research of interactive systems. However, we find the dual concept of *strategies* and *tactics* more useful for our purposes, since the use of the word appropriation does not reveal the power structures inherent in designers’ work, as the term itself refers only to users. We deem it necessary to reflect on designers’ intentions, as these have a profound impact on how technologies eventually take shape, and what tactics or appropriation techniques are available to users.
the overall hotspots to a large extent. Although they are three-dimensional objects, they seem rather two-dimensional. As such, the realm of possibilities for embodied interaction tactics is limited. This a design challenge which is inherent to situated displays. This particular design issue does not present itself in the case of the wireless panOULU network.

Concerning sense of place, the displays’ digital content is predetermined and has not yet been tailored to their individual places for the most part. They offer a wide range of e.g. information services and games, but they do not leave much space for creativity or active production. We can conclude that applications are probably so tightly fixed, that people find it difficult to merge them into their everyday practices, leaving hardly any space for their tactics. This argument is also supported by the fact that some applications have been misused, or people are just toying with them. [9] It seems that despite the strategies inscribed into this particular technology, people have been searching for creative ways to use and domesticate it. This is further supported by the fact that some playful applications that can be used by groups of people have been popular, such as the UBI post card [15]. Furthermore, the amount that the applications are used has been found to differ from hotspot to hotspot [11], indicating that different places indeed might require different content. In contrast to the displays, panOULU’s use is not restricted to certain predetermined applications. Also, people can (and must) use a technological device of their choice, thus forming a familiar experience through a personal interface. As such, we can argue that panOULU leaves plenty of space for tactics and thus caters for countless ways to include it into citizens’ everyday practices.

Finally, it is important to note that the interaction space within a public place offered by the UBI displays does not have a predecessor in the citizens’ mediascape; consequently, data from our deployment has shown that people have difficulty even imagining beforehand what kinds of services they would use on such devices [11]. A big public interactive screen also breaks down the boundaries between small, interactive private screens, such as smartphones, and large non-interactive public screens, like ads. This kind of a technology, then, is harder to adopt than more familiar forms of ICT, such as wireless networks, that many people already have at their home or at workplace.

Towards meaningful interaction spaces

The analysis presented in this paper shows that while the technologies are developed to a technologically high degree, they should also be developed towards a more experiential and participatory direction. By exploring different aspects of the built environment and the practices citizens engage in within it, then, we aim to add to and support existing meaningful experiences in the city. Rogers [17] has already made the case for experiential computing from an HCI point of view, and McCullough [12] has argued for locational technology from his architectural standpoint; we seek for a deeper connection between technology and place as well as deeper understanding between technology and everyday practices [5]. On a practical level, we would like to see a further bridging of the digital and the physical in Oulu. Specifically, how can our location support a digital locale that would share a singular sense of place with the physical locale? The two technologies analyzed would be a great supporting infrastructure for such a digital locale. Key research questions would be: What would this public virtual
Examples of further developments

- The hotspots could be developed further towards physical forms that would allow different spatial co-presence and co-use patterns, and towards content that would entail meaningful, context-driven applications. Another important question is, how can we make a universal screen more communicative to its indented audience?
- If the hotspots were to be interactive on all four sides, a different, perhaps richer, dynamic between co-located users might emerge.
- On the existing screens this could be mitigated somewhat by introducing a see-through mode which would utilise the two cameras. Mediated and non-mediated interactions could occur between two people in the same physical location using the same screen, whilst augmenting the cityscape that they see through the screen, bringing together the locale, the people and the digital content.

To explore how the content could be further aligned to suit the sense of place, for instance, by utilising the unique identity, history or functionality of the main square or the marketplace.
- We aim to explore the panOulu’s possibilities for developing the relationship between the citizens, the locale, its sense of place, and urban technologies.

space be like? How can we connect sensors, GIS, social media, and existing applications into a meaningful, virtual urban space, and how would this connect to the physical urban space? What needs do local communities have that could be served by such a digital public space? How would this affect the identity and sense of place people associate with Oulu? And most importantly, how could we empower citizens to use this layer towards their own creative and productive purposes?

Acknowledgements

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References

Inaccessible Augmentations: Ambient Displays’ Two Sides of Space

Abstract
An analytical study for designing space with embedded ambient displays as a dual system that shares physical and hybrid characteristics requires an intersection of Architecture and Human-Computer Interaction. In this paper we propose to examine the application of research methods for understanding the impact of ambient displays in architectural design through Space Syntax theories, which confines a set of theories and techniques for analyzing space.

Here we present an early approach for developing a theoretical framework for understanding the complex relations between ambient displays, physical space and humans; and the impact of augmented projections on people’s navigation in space and to a greater extend the socio-economic implications.

Author Keywords
Ambient display; architecture; movement; space syntax; hybrid space.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

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Introduction

The introduction of digital technologies in architecture has allowed the formation of new relations between space and people, redefining the spatial properties of the environment. Embedding ambient displays in design requires a new way of thinking of how these systems interweave with architectural space and people’s perception. Ambient displays can simply augment walls creating more pleasant environments [1, 2] without changing the physical morphology of space. Such augmentations allow space to be transformed into a dynamic environment in which boundaries are dissolved. Our interest lies in extending and adapting our understanding of architectural design by looking at space as a dual system of physical and virtual properties incorporating human’s behavioral and perceptual changes.

Two Sides of Space

It is generally accepted in architecture that the structure and configuration of space affect people’s navigation and movement. Gibson’s research, which was primarily developed for visual perception, suggests that our senses provide us with direct awareness of the external world and its properties [3]. People perceive space with their senses and act accordingly, thus there is a tight relation between perception and movement. ‘Space Syntax’ research shows that the majority of human movement occurs along the longest lines of sight, and that the more open visible space we have in front of us the more we tend to move towards that direction [4]. The emerged movement patterns not only influence the dynamics of the built environment but also shape social behaviors and co-presence in space [4, 5].

![Figure 1. Ambient display as digital transparency.](image)

The placement of an ambient display in physical space introduces a transparent layer of a dislocated virtual depth. This interface can be considered as a digital opening in a form of a virtual window that extends both architectural space and the vision of users in a given space. Like a window that connects two physical spaces transferring information between them, an ambient display can be seen as a link between physical and virtual worlds.

Drawing on this approach, we suggest that the factors that determine the impact of ambient displays on people’s behavior are (i) the content of the display and (ii) the relation between the physical and projected virtual spaces.

When mentioning the content of the interface, we refer to the visual depth of the ambient projection. As revealed from previous research [6] an ambient display
that shows typical two-dimensional information has no change on pedestrian route choice behavior. When the display shows a projection of another space, the presence of the augmented visual depth influences route choice behavior.

The second factor highlights the importance of the projected vanishing point. A non-centered perspective projection of a space influences route choice behavior towards the side of the projected vanishing point [7]. Moreover, a skewed projection changes the geometric representation of space and lengthens the line of sight towards the side of the vanishing point. Therefore, a subliminal direction is imposed towards this augmented longest line of sight.

Figure 2. Example of ambient display with skewed projection.

The introduction of new transparencies through the use of ambient displays extends physical space into virtual world creating a dual system with new spatial configurations that challenges human’s perception of space. The emerged spatial configurations include properties and relations of the physical space and all those relations rising from the presence of the virtual projections. Based on Space Syntax, spatial layouts affect functioning [8,9]. It is also suggested that movement patterns influence the co-presence in space and thus the social interaction. We believe that this impact will be more intense in hybrid environments where the augmented virtual depth makes the visibility and angular relations fluid. Indeed, the introduction of ambient displays in space can engage people to adhere to certain kinds of desired movement patterns [6,7].

Figure 3. Augmented visibility diagram.

We have so far argued that an ambient display can affect the following:

(i) Spatial configuration
(ii) Movement patterns
(iii) Social interaction / co-presence
As previous research reveals [10,11], each of the above factors plays a critical role in determining the socio-economic life. Therefore, any occurring change that reforms the existing relations among them can have a certain number of ramifications. We suggest that the placement of ambient displays can contribute in the formation of desired socio-economic relations within space.

Conclusion
We argue that embedded ambient displays influence people’s perception of space and alter the existing spatial configuration. Moreover, an ambient display that extends the visual depth into space can engage people to follow certain kinds of desired movement patterns. This change can be strengthened further when repositioning the projected vanishing point. Drawing on these observations and the consideration of different levels of social interaction that occur in environments with ambient displays, we propose that the presence of ambient displays in physical space can influence the existing socio-economic factors. We understand that further analysis and experimentation is needed in order to analyze the impact of ambient displays and design a complete framework that addresses all the factors discussed above.

References
Mammoth Stickman plays Tetris: whole body interaction with large displays at an outdoor public art event

Abstract
We discuss our experiences running a large interactive exhibit called Tweetris. Tweetris incorporates whole body interaction with large projected displays in a public setting. We highlight aspects of crowd engagement, particularly the impact of the exhibit’s layout on engagement patterns, and aspects of the exhibit’s design that encouraged playful interaction between audience and "players".

Author Keywords
Whole body interaction; Tetris; Twitter; public installation; Kinect.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Tweetris is a lighthearted whole-body interactive exhibit employing a game-within-a-game concept (see Figure 1). In the shape-matching game, players compete to make Tetris shapes (tetrominos) with their bodies. Snapshots of players making these shapes are tweeted, then used as tetrominos in a life sized game of Tetris, where players control the placement of
tetrominos with their bodies. The same tetrominos are made available to use in an online/mobile game of Tetris.

Tweetris is a collaboration between HCI researchers at Dalhousie University and University of Toronto, and digital media artists, researchers and designers at OCAD University. It has been successfully exhibited at public art events, and academic and industry conferences, most recently taking the artist award among 84 exhibits at Nocturne in Halifax, Canada.

Building on traditions like charades, and games like Twister and Hole in the Wall, Tweetris provides a venue for using the body to engage in social creative expression, friendly competition, and even lighthearted public embarrassment. Tweetris explores what it means to engage in a public interactive game. Players are not only contorting in front of an audience: shape matchers serve as game pieces on the Tetris board, are placed on a public Twitter feed, and used in an online game, while Tetris players drive a 30-foot stickman watched by crowds of onlookers and curious passers-by.
Shape Matching
In the shape matching game, two players entered a van, where they viewed a video mirror image of themselves. Translucent tetrominos appeared on the video image (one for each player), and the players raced to fit their bodies inside the shapes. As a shape was made successfully a snapshot was taken of the player, to be used in the rest of the exhibit. The first player to reach 10 successful shapes "won". The shape matching game is described in more detail in [1].

Tetris Wall
In the second game, individual players moved their body to control a game of Tetris. The game was projected onto a white tarp covering a building face, on a busy street, giving a 30-foot game board visible from about 1 block away. The tetrominos are a mix of coloured blocks and the shape-images made in the shape matching game. Moving from left to right moved the active tetromino in the same way, crouching down on the ground caused the tetromino to speed its descent, and using the arms to make a broad rotating motion clockwise or counterclockwise caused the tetromino to rotate in the same direction.

Exhibit Layout and Crowd Engagement
In Figure 2 we show a labeled top-down view of the exhibit area. Lainer and Wagner [2] provide a set of primitives for describing a space in terms of social impacts that are useful for this discussion. Dotted lines in the figure indicate social transverses: the circular regions are areas of common activity, while the arcs show paths between regions. We use the terms region and path instead of transverse here to avoid confusion. The dotted regions grow and shrink in the intermediate spaces around them as crowd size changes. The viewpoints (or vistas) between regions influence engagement patterns and overall cohesion. Attributes of the physical setting combine with the placement of media and play spaces to suggest transformation layers delineating regions.

As people approach they have three possible paths into the exhibit. The first (leftmost in Figure 2) leads them to region A. In this space the Tetris game was clearly visible (display a) as was the play area for the game (region i). The rest of the exhibit was not easily visible from this point. Volunteers for the Tetris game were taken from this region.

The second path leads into region D. This was a popular entrance point, with a good viewpoint (vista) from which to read the exhibit introduction (kiosk d), watch the Tetris game (display a), and see the TwitPic feed (display b). Moving into the exhibit allowed visitors to also see the shape matching game (display c). In region D attendees were often heard trying to understand how the parts were connected, or explaining how they were connected to others.

The third entrance path opens into region C. In this region many were focused on the local event (the shape matching game inside the van), forming an oblong ellipse around the entrance to the van to watch, and forming a line down the middle to participate. Because of the viewpoint, however, some attendees in this region also watched the Tetris game.

In the middle of the exhibit was region B, where the live TwitPic feed was displayed (display b). Shape matching game players often migrated to this area to see their images appear on the feed, and to watch the Tetris game. These players would occasionally call out when they saw their images appear as tetrominos on the Tetris game.

The road imposed a strict limit on the exhibit region, but also created a distinct area for “Tetris watchers” (region F). At times this area was crowded with onlookers, who snapped photos and talked casually about the Tetris game. The road served as a clear boundary between direct engagement and observation. Observation at this distance was only possible due to the very large screen—this is in contrast with a smaller screen, which, like a busker, requires proximity and carries the potential of being “drawn into the show”.

We label the nearest sidewalk region E, because we saw a particular kind of engagement in this space. Some passers-by would often casually look, slow down, even stop for a minute on the sidewalk, but would not leave the sidewalk—maintaining a clear social cue of the ability to disengage at any moment.

The A/V van housing the large screen projector (shown as a rectangle in the center of Figure 2) had a large effect on the social experience of the exhibit, illustrating how critical layout choices are to the experience of large scale public interactive exhibits. First, it effectively separated region A from the rest of the exhibit, making the Tetris players a somewhat separate group, while visitors more fluidly transitioned between regions B, C, and D. Relatively few people walked in front of the large projector to get to region A.
(even though the projected region was considerably above their heads), and others simply didn’t see the crowd in region A from the other side of the A/V van.

The van also blocked the Tetris play space (region i) from view for onlookers further away, particularly in region F. This created an experience where these onlookers could see the indirect effect of whole body interaction on the movement of the Tetris pieces, while also seeing its direct manifestation in the stickman superimposed on the game area. These elements combined to create a puzzle for onlookers to figure out. Some thought the stickman was pushing and rotating blocks with his hands, while others picked up on the correlation between poses and tetromino movements.

We provided a smaller video feed of the player (life sized) to the right of the game area, which onlookers would sometimes refer to in conversation with each other as they tried to decipher what they were seeing. Some thought the stickman was pushing and rotating blocks with his hands, while others picked up on the correlation between poses and tetromino movements. We provided a smaller video feed of the player (life sized) to the right of the game area, which onlookers would sometimes refer to in conversation with each other as they tried to decipher what they were seeing. The shape matching game couldn’t be seen from this viewpoint—one onlooker noted that the blocks seemed to be images, but she didn’t know what of.

**Game Design and Crowd Engagement**

Both games permitted playful experimentation, increasing crowd interest and engagement. By only requiring that a shape be matched (but not how) in the shape matching game, we saw many examples of odd/difficult contortions when making shapes (see Figure 3). In the Tetris game, the rotation action was difficult to achieve—this led to some comical experimentation. One attendee even turned cartwheels to rotate the pieces.

The sheer scale of the Tetris display meant that the Tetris game captured most of the crowd’s attention in the Nocturne event. Loud communal “ooohs” and “aaahs” and shouted suggestions were heard throughout the event as tetrominos were moved into good or bad positions. In a prior Tweetris exhibit, the shape matching game was in its own setting—garnering similar attention albeit from a smaller crowd.

The human tetrominos had more appeal as personal tokens—groups of friends would laugh together when seeing them on the TwitPic feed or Tetris gameboard—rather than having appeal to the larger audience. Making the images larger and clearer may change this.

Even though many attendees couldn’t see the Tetris player, a sense of connection was created through the medium of the game screen, and players appeared to enjoy the audience. We would like to further explore the role of the stickman in contributing to this.

**Conclusion**

We clearly see the influence of both the local environment, media placement, and interaction design on the way the audience engaged with Tweetris. We hope to engage with others at the workshop to explore ways of studying these effects in future work.

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Playful Interactions Stimulating Physical Activity in Public Spaces

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Abstract
In this position paper we describe our vision on designing playful interactions to persuade people to be physically active in public spaces. Social embeddedness and playful interaction are the core elements of this vision. We illustrate how our design vision is incorporated into innovative concepts that stimulate physical activity for various user groups and in various use contexts, and present some general findings on the basis of these cases. New technologies such as mobile networks and social media provide new opportunities for creating location-independent solutions that support groups of people to motivate each other to be physically active by creating challenges for each other. Designing playful solutions for public spaces asks for low-threshold solutions that support easy stepping in and stepping out solutions.

Author Keywords
Playfulness; persuasion; physical activity; interactivity; public space

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.
**Introduction**

In this position paper we describe and illustrate our vision on designing playful interactions to persuade people to be physically active in public spaces.

The ever-increasing use of Internet and other digital media (such as computer games) tends to weaken the importance and use of the urban public space. Meeting places seem to have shifted from real spaces to virtual spaces. In addition (and perhaps as a direct consequence), we see a worldwide trend that people nowadays lead less active lives than people used to. Lack of physical activity is a persistent problem for both young and older people, which may cause obesity and other health-related problems. Professionals as well as commercial and public organizations who are involved in promoting a healthy lifestyle, such as coaches at sports schools, people who organize sports events, activity consultants, etc. are constantly looking for ways to motivate people to lead an active life, in order to prevent lack of physical exercise and obesity. However, interventions that fail to address a strong intrinsic motivation are unlikely to be effective on the long term. In the SIXPAC (Social interaction to eXcite Physical Activity) project, an international consortium explores the power and potential of interactive technology - such as games and social media - for stimulating physical activity in public spaces.

In our research we apply two design principles: **social embeddedness** and **playful persuasion**. Social embeddedness because social interaction has been shown to be one of the prime motivators for (physical) activity: people like to take part in social activities. In their theory on intrinsic motivation, Ryan and Deci refer to Relatedness as one of the three basic psychological needs (besides Competence and Autonomy) [6]. They define relatedness as the universal want to interact, be connected to, and experience caring for others. Concrete examples of social motivations to take part in an activity are to play in a team, to make new friends or to be together with friends. Therefore, for an activity to be intrinsically motivating, it should be embedded in existing social structures and activities. In the context of public spaces it is interesting to examine the voluntary nature of deciding to participate in a social activity. Playful persuasion because we follow a novel approach in which we examine how we can influence people’s behavior by combining subtle persuasive mechanisms with playful interactions tied to existing daily practices. The assumption is that by incorporating playful experiences, such as curiosity, exploration and nurturing [4] people will be motivated to perform certain behaviour by appealing to intrinsically motivating strategies [5]. In the context of public spaces it is interesting to examine how to select appropriate experiences suitable for a context and related user groups.

In sum, the aim of the SIXPAC project is develop and study innovative products and services that resonate with the lifestyle and interests of the end user: products and services that motivate people to be physically active because they are both socially embedded and fun. In particular, these two design principles are applied to products and services to be used in public space, where contextual factors largely affect how interactive products are designed and used. In this paper we illustrate how social embeddedness and playful persuasion are incorporated into the design of three innovative concepts developed by students within the SIXPAC project.
In subsequent sections we will discuss examples of related work, both commercial and scientific. We will then illustrate the design vision described above by means of three case studies and conclude by discussing a number of general findings.

Related work
A well-known example of playful persuasion in a public space is the Piano Stairs, an interactive staircase that looks and sounds like a huge piano, which motivates commuters to take the stairs instead of the escalator. Our own work in the area includes an interactive ball pit for young children [1] and an interactive video installation in a corridor for teenagers [7]. We have also designed a playful persuasive system for elderly users in a care home, called the Activator. This system provides information both about personal and group behavior of people living in a care home [5]. Other relevant examples of playful persuasion include apps for mobile devices. A good example of such an app is Figure Running [2], in which users draw a shape on a city map by walking, cycling or running around, on the basis of GPS. For some users, the act of drawing while exercising is enjoyable. For others, sharing their drawings with others or trying to recreate a peer’s shape is most engaging. Two other examples of interactive products, but fixed to a specific location, are playground installations such as Icon [3] and YalpSutu [9] which create interactive areas in which several active games can be played.

Design cases
In this section we describe three examples of innovative concepts that have been designed to stimulate physical activity in public space in a playful way.

sTail
Description: sTail is an interactive, active game designed to be played in public spaces, such as a shopping mall or a town square. The playing field is projected on the floor. When a person enters the playing field, he or she automatically gets a virtual tail, which follows you around. Once players have a tail they can start to chase other players and steal their tail, by stepping on it. If a player steals another player’s tail, his or her own tail will grow longer, while the other player’s tail shrinks. The concept is fixed to a specific space, and the size of the playing field depends on the limitations of the size of the projection. The field be entered from different directions depending on how it is positioned in space. The use of sTail is characterized by incidental use of passers-by.

Social Embeddedness: The game can be played by any group of people who happen to be in a specific location. The game stimulates interaction between people who do not know each other, but it can also be played by groups of people who do know each other. As soon as a passer by enters the playing field (intentionally or unaware) they automatically become part of the game: a tail is attached to them, which can be stolen by other players. Because the game mechanics are very simple, everyone can decide to stay or leave, to join the game or create their own games.

Playful Persuasion: sTail incorporates the following playful experiences: Control (the players can jointly influence the speed of the game, and create their own games), sensation (this includes experiencing how the tail follows you through space) and competition (players will try and get the longest tail and steal the
tail of another player). The mechanics of the game are simple, and there are no specific rules or goals except for growing your tail by stealing another player’s tail. This makes it very easy to enter the game and play. Also, it allows the players to make up their own games, which ensures that the game is also fun for ‘experienced’ users.

Photo Quest

**Description:** Photo Quest is a casual game, designed to be played on a mobile phone. It is intended for moments when people have to wait, e.g. for the train or for an appointment with a friend. The Photo Quest app shows a photo of an object or location close to you. The challenge is to find the location of the photo and the location where the photo is taken from, and then reproduce the photo. In first instance, the photo will be shown blurred, but over time more and more details are revealed, until it is completely recognizable. The faster you are with recognizing and ‘scanning’ the right spot, the more points you get. Photo Quest is a game that can be used by everyone who uses a mobile phone with a camera. The app is flexible in use. It can be used both indoor and outdoor, in private as well as public spaces.

**Social Embeddedness:** The game can be played by single players or a group of players. Photo’s can be selected from a standard collection on the basis of a player’s location. This can appeal to people in the form of joining a community, similar like joining a geo-caching community. Alternatively, friends can generate quests for each other by taking a photograph and sharing it. Players will then pick up the challenge and try to find the photo. This appeals to a more personal form of social embeddedness. The challenge can be shared by multiple people, and comparisons can be made based on who found the location the fastest. People who create the quest, can be creative. For instance they can leave hidden messages to be discovered by finding the right location.

**Playful Persuasion:** The design incorporates the following playful experiences: challenge (players have to try and find the photo within a limited time frame), exploration/discovery (users will have to explore the area around them to find the location where the photo was taken), and expression. Depending on the kind of photos that are taken the game can be a medium to make other people look at the world around them, for example by taking photos from unexpected angles. We have also seen people incorporating messages in the photo. Because the manner in which the photos are chosen and used can vary, the type of experience can also be adapted to specific user groups interest. The app uses the property of flexibility, in that it can be played anywhere, and has a low threshold to participate. The app seduces people to explore a public space, which could be done by multiple people at the same time, to also allow face-to-face interaction when trying to solve the challenge.

WaterDraw

**Description:** Waterdraw is an active game to be played in a swimming pool which is equipped with a large screen. Swimmers move around in the water with colored foam blocks. Their aim is to conquer parts of the screen (which is positioned either on the wall or in the water) by painting it in the color of their foam block. Whoever colours the largest part of the screen, within a limited time frame, wins. To make the game more challenging, there are randomly placed bombs.
and balloons on the screen, which when triggered either help or sabotage the player. In the creative mode players can draw whatever they want using the two coloured foam blocks. The context of use is limited to a specific space. It can be used in the water as well as outside the water.

**Social Embeddedness**: WaterDraw has been designed to be used in a swimming pool, a semi-public space where people usually go with friends or family for recreation, or individually when sporting. WaterDraw is played by two or more co-located players at the same time. They can either play against each other in the game mode or work together to draw a piece of art in creative mode. Depending on the available space this game can also be played with groups of people. Characteristics like play sessions that are defined by time, getting hold of the foam and creating groups could increase the intention to participate in the game. This game can be played by people that already know each other, or teams might be formed facilitated by the location’s staff. It can also be used in the context of other arranged activities in the pool location, such as school classes visiting for swimming activities.

**Playful Persuasion**: The following playful experiences were incorporated in the design: challenge (a challenge is presented by the limited time available for finishing the task in the default mode), competition (when players compete for colouring the biggest space), and expression (in the creative mode players can express themselves by making any kind of drawing using the sponges) and sensation (the fact that the game is played in the water and that physical exertion is required to play, provides for a meaningful sensory experience). The concept allows multiple uses in a specific public space. It can be switched on and off, as time requires and thus allows incidental use.

**Discussion and conclusion**

Technologies such as mobile networks and social media provide new opportunities for creating location-independent solutions that support groups of people to motivate each other to be physically active by creating challenges for each other. We have shown how a variety of playful experiences can be applied to elicit physical activity in public spaces, ranging from expression to challenge, depending on what is appropriate for the user group and the context. Because of our interest in eliciting physical activity, two design cases incorporate full-body interaction as main interaction style. However, the Photo Quest design cases incorporates a more global form of GPS-based interaction with the system.

We conclude that designing playful solutions for public spaces asks for fluid shifts between different forms of social embeddedness. It is important to provide low-threshold solutions that support easy stepping in and stepping out solutions. It. For example, shifting between the role of being a participant or being a spectator. Being a spectator and providing advice can also be part of the fun. The game design rule: easy to use and hard to master is especially important for walk up and use like solutions for public spaces. The voluntariness of participation is another important aspect to take into account when designing for public space. Of course, selecting the right playful experiences can motivate people to join in. Also, flexibility in the number of players participating in the interaction will increase the applicability in diverse public contexts of use.
Secondly, because of the nature of public spaces and the variety of citizens in public spaces, play solutions should offer game experiences that offer ‘something for everyone’. In future this could lead to adaptive game scenarios. The intertwining of the virtual and reality space in intelligent public playgrounds is an interesting topic for future research.

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**References**


Bringing Performance Art into Everyday Life Situations

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Abstract
This position paper presents the concept of a tangible and modular interconnected "platform" for interactive digital artworks in everyday environments. Furthermore it presents a proposal for the study of human-human interaction through the use of digital systems embedded in these platforms. Finally a particular realization of this concept is proposed and discussed: A modular interconnected sensor system that mediates team based physical exercises in a fitness or rehabilitation training situation.

Author Keywords
Collaborative interfaces; interaction design; user studies; media art; exergaming; performance; improvisation; co-expression; social learning.

ACM Classification Keywords

General Terms
Human Factors, Measurement, Experimentation.
Introduction

What if interactive art could be enjoyed through group performance situations done by "laymen" in everyday life situations?

Then perhaps some of the challenges with interactive art in museums and galleries could be addressed. For example it can be difficult to create “deep” interaction experiences in exhibition contexts. By deep is meant a) an interaction experience that lasts more than a couple of minutes and involves the user on a different level than the level of a “visitor”, b) a continuous play with the interactive medium where several phases of interaction are entered in one interaction session, c) a chance to revisit the interaction experience and perhaps enter it from a different angle, d) a chance to master the forms of expression that the interaction offers, so that collaboration about interaction and expression is possible.

The aim of the present concept (see figure 1) has been to present a possibility to study long-term and recurring interaction with digital artworks in public and semi-public spaces. A sub-aim has been to move focus from human-computer interaction to the human-human interaction that happens through the use of a computer system, where the tangible-digital medium is a facilitator and mediator of an array of socio-aesthetic relationships. Examples of approaches to how this can happen can be found in [4, 6, 10, 20]. Some of the works described transcend the exhibition context in that a) they offer long-term interaction and playfulness, b) they are platforms for new possible interactive artworks and compositions, and c) they provide users with the kinds of physical affordances that allow for interpersonal interaction through a tangible-digital and spatially (socially) distributed interface.

This position paper draws a distinction between the physical part(s) of the artwork as the tangible “platform” and the many different digital interactive artworks that can be installed temporarily in this physical platform. This paper opens up for the idea that there can be a consistent user group around the physical/tangible parts, and an artist community that continuously provides new works (and new forms of interaction) that can “inhabit” the physical element(s). Figure 1 shows how there can be a continuous flow of digital artworks that are downloaded and installed in the physical platform. The flow of artworks becomes an iterative design process that is shared by the artist-, developer-, composer- and designer community.

With the need for digital-tangible interfaces that are as solid as playground equipment, street furniture or consumer products, this distinction may help to develop designs of interactive art as “consumer products” that leave the one-of-a-kind prototype culture behind [12]. This will of course question the originality of the artwork, nonetheless make the physical component of the artworks less fragile and more available in different everyday contexts and environments. In addition to this artists must be ready to share a physical interface and perhaps develop it together over time. Already now designers and artists share the open source communities of the Arduino, the Lilypad and Littlebits [1, 14, 15].

But why would the “digital inhabitant” - the interactive software system - be seen as an artwork when considering the fact that it has the status of a computer?
A game that can be downloaded into something that may seem like a commercial game system? A hypothesis is that the aesthetics of the physical component(s) and interactive experience differ from typical game experiences in that they offer possibilities of exploration and expression. The process of interacting with such an interface could be an iterative process where the user(s) continuously move(s) between explorations and performance. An example of such a digital interface could be Björk’s album Biophilia, released in 2011 in the form of an app [3]. Other examples of interactive artworks that inhabit a device would be the music compositions for team performance described in [16,18].

The Fitness Art Performance Concept

In the following there will be a presentation of proposal for a very specific realization of the present concept. The proposed realization consists of a wireless interconnected modular sensor system that can be attached to training equipment in the semi-public environment of a fitness- or rehabilitation center (please see figure 2 for more detail). The software applications embedded in this system can, if developed according to specific group training sessions, contain the following design opportunities and research:

1) The interface: It can be a platform for interactive sound and visual compositions that can play out in the social context of fitness or rehabilitation training sessions. When artworks are downloaded into the relatively neutral interface parts they become social objects that stimulate particular forms of user interactions [12].

2) The users: Through mediation of simultaneous physical movements and group dynamics, it may be possible to encourage users to find and learn accuracy of movement and rhythm, as well as physio-social communication, improvisation and team spirit. Users take in the role as creators of expression - the training is internally directed and socially coordinated (see figure 4). Methods used in embodied music cognition, [9,11,13] and conversation and interaction analysis [8,17,19] can be used to get an understanding of the physical and social learning that may happen in such scenarios.

3) The training culture: The modular system can provide physiotherapists and fitness trainers with a new tool to obtain focus and concentration in the training situation. A hypothesis is that the goal of aesthetic expression in a social atmosphere makes efficient training possible.

4) The user community: If the modular system was available to individual users as a series of affordable and networked physical components, then user teams could meet and perform together through the use of a particular interactive artwork or composition.

5) The artist community: If a set of basic example training programs and their corresponding logged interaction data was documented online, different artists, designers and composers could create interactive artworks that facilitate the series of movements required in particular training sessions as well as new forms of expressiveness that require physical effort.
The Interface Platform
The interface platform consists of identical wireless interconnected modules. Each module can send interaction data, and receives control data for LED lights and actuators embedded in the module (see figure 3). Magnetic connectors make the sensor modules flexible [15]: Multiple sensors can be attached/detached from the sensor modules during one single training session. Two buttons allow users to switch between the feedback modes that correspond to a particular training instrument-sensor combination.

Visual, sonic and haptic mediation of physical effort can be used in different combinations and scenarios. Sound feedback that is available to users in all training positions could mediate physical movements, while visual feedback could be used to create a special aesthetic atmosphere [5], or for game oriented action. Haptic feedback could indicate individual training accuracy, and possibly an aspect of the current shared condition in the training situation.

A Discussion of Fitness Performance Art
The implementation of artworks in for example fitness training equipment allows the artwork to be distributed in the city landscape and co-exist with an activity that people do on an everyday basis - the artworks become part of everyday popular culture and form a new kind of "folk art" that is available to everyone in their different local communities.

Because the artworks are available to be performed in the so-called "mundane" environments, there is no distinction between "artists" and "spectators". Instead the idea of the "artist" is distributed into two different roles: a) the creator of the interactive works becomes a facilitator of specific artistic experiences, while b) the people who experience the artworks become active performers through the roles they take in, when they engage through their physical performance and social commitment.

The fitness scenario contains elements of folk art, where a tradition allows everyone to create and share the artwork through their active participation [2]. In a sense, a whole new set of public performance traditions could be implemented via the digital artworks that are downloaded into the art platforms.

While the fitness scenario may not be a very innovative scenario in terms of a "platform for art", it has been used as an example, because it supports a commercial movement that is already "in fashion" - something that people are familiar with. A hypothesis that can be discussed and tested is how the level of familiarity a) makes people readily understand and engage with the interaction possibilities, and b) makes it possible for companies to engage in the creation of platform elements, because they see a commercial interest.

However, this kind of standardization of the artistic research practice may not necessarily be a good idea, because we may end up with something conceptually analogous to the idea of the "museum" and "exhibition space". Perhaps there is a price to pay when possibilities for expression and user experience are reduced to for example fitness equipment?

Several experiments with art as "use objects" in everyday environments need to be done in order to investigate the balance between the contribution of the art facilitators and the art performers (the users). Both are – after a while - partners in the development of a shared artwork, and designers, artists and composers can learn from the way people naturally express themselves in a social environment.
Acknowledgements

I thank colleagues at my research institution for their critique of this concept, and their suggestions and comments.

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http://www.arduino.cc/.


Using Participatory Performance to observe Social Encounters in Public Space

Abstract
We describe how we have used the participatory performance medium to explore social interaction in public spaces by describing the design and enactment of two performance projects, *humanaquarium* and *Nightingallery*. We discuss how the performances were used to explore social behaviors in authentic public contexts, and suggest several avenues for future investigation of social phenomena observed in participatory performance scenarios.

Keywords
Digital arts, participatory performance, experience-centered design, practice-based research, interdisciplinary design, research in-the-wild

ACM Classification Keywords
H.5.2 User Interfaces (D.2.2, H.1.2, I.3.6)

Introduction
This article describes an ongoing process of practice-based research in which the creation and enactment of participatory performance pieces is used to investigate social interaction in public spaces. Our research team composes participatory performance pieces in which team members Taylor, Schofield and Shearer take active roles as performers, engaging in creative
improvisation with members of the public. This method of practice allows us to interrogate shared social scenarios by taking part in the collaborative performance firsthand, enabling us to examine the experience from within [10].

The participatory performance medium differs from traditional performance in that in addition to the conventional roles of performer and audience/spectator, the role of participant is added to the performance frame [1] [9]. Much research in current CHI literature explores how explicitly inviting spontaneous contribution from untrained individuals who are new to the encounter helps shape a collaborative creative experience. In particular, research has focused upon the practice of transitioning from spectator to active, `witting' participant [7] and how such transitions can be encouraged in informal, `guerrilla' style scenarios [8] [9], how encounters with interactive performance can be considered as trajectories through shared social experience [2], and how performance experiences can be mindfully crafted so as to most readily satisfy the needs and expectations of those who take part in the shared experience [6].

Our research practice focuses upon exploring how participants encounter and experience interactive performances which are characterized by their ambiguous, ludic [3] qualities – our performances feature interactions with technologies that are deliberately ambiguous and open ended, with the intention that participants must experiment and explore the interaction mechanisms so as to discover their functionalities.

This article describes two performance pieces, *humanaquarium* and *Nightingallery*, that we used to investigate social interaction in public spaces. We describe the design considerations that factored into the conceptualization, creation, and enactment of the works, and suggest how the use of the participatory performance medium could facilitate future investigation of social phenomena identified during the course of our practice-based research.

**Staging Performances to Explore Social Encounters with Technology**

Our research team created several performance pieces designed to explore how passersby engage with playful, creative technologies encountered in public spaces.

Consistently present in our practice was a thread of investigation surrounding the question of how participants would engage with novel, unfamiliar technologies when encountered in authentic social spaces, remaining mindful of the social considerations that necessarily shaped and framed the encounter. Our manner of experience-centered design and evaluation practice conceptualized the participatory performance in terms of McCarthy and Wright’s threads of experience [5]. We considered participants’ encounters with the performances in terms of their *sensual, emotional, spatio-temporal, and compositional* aspects. Congruent with other experience-centered explorations of aesthetic interaction [11], we attempted to holistically address an individual’s engagement with the performance artefact, accounting for the socio-cultural factors influencing how the participatory performance experience was individually appropriated and personally understood.
Between 2009 and 2012 we developed several performances that were enacted in a variety of contexts. These included unstructured settings like museums halls and festival venues, as well as more formal exhibitions in concert halls or galleries. As we designed our pieces to be flexible and reconfigurable, we were able to adapt them as needed so as to accommodate a variety of different social scenarios within which they could be performed. This allowed us to stage the works under a wide variety of situational constraints, enabling us to study how participants engaged with them under a wide range of authentic performance contexts.

As we wanted to use the performances as a platform for investigation, the technological aspects of each performance were designed to have affordances intended to elicit and provoke the particular social behaviors we wished to interrogate as part of our research process. Additionally, although each performance was conceptualized to explore particular research questions from the outset, we were careful to design the works so that they remained sufficiently open, flexible, and participant-driven enough as to allow us to learn from the unpredictable experiences that would inevitably occur through the course of situated research-in-the-wild. By structuring the performances in an open-ended fashion, we were able to observe and encourage social interactions as they were encountered, and were able to refine and evolve future enactments of our works so as to follow up on these potential avenues of research as they presented themselves.

**humanaquarium (2009)**

The *humanaquarium* project was designed to investigate how participants could take active roles in shaping the development of an improvisational audio-visual musical performance piece [10]. Each performance saw Taylor and Schofield (both of whom are trained musicians and professional performers) seated on the ground inside a transparently fronted 1.5m cube. Inside the cube, Taylor sang soprano, and Schofield played mandolin as well as various electronic interfaces. Their improvisations were mapped to visualizations that were projected behind them on the rear surface of the cube, allowing the cube structure to function as a small staging space which framed the performance. Participants were invited to co-create the musical performance by manipulating Taylor and Schofield’s improvisation via the transparent screen. The screen was implemented using FTIR technology [4], enabling participants’ touches on the surface to be translated into audio-visual effects that were applied to the musical performance. During performances, Shearer was able to engage and interact with participants, taking part in the installation alongside them, outside of the box enclosure.

The design of the system was primarily intended to explore how participants experienced the co-creational aspects of the performance encounter. During the development process, attention was paid to understanding how our design choices affected participants’ experience in terms of how to minimize stage fright, increase potential for collaboration, and experiment with varying degrees of legibility in order to create a stimulating, playful experience [10].
The design for the Nightingallery project grew out of experiences we had with humanaquarium. We were interested in further exploring how participants could appropriate a participatory performance interface in order to contribute artistically to the creative experience, enabling what Sheridan terms a ‘witting’ transition [7] from participant to performer. In addition, a second avenue of inquiry arose resulting from an interesting collection of interpersonal interactions that we noticed taking place between participants as they encountered and played with humanaquarium’s interaction paradigm. In order to further investigate these phenomena of performance appropriation and experience sharing, we conceptualized a design for the Nightingallery project. Nightingallery featured an animatronic bird that users could communicate with via a vocal interface. The bird would move and sing in response to the verbalizations of the participant. We envisioned encounters with participants to take the form of improvisational street theatre in which Taylor, Schofield and Shearer engaged with the scenario by playing the roles of minders and assistants to the bird character, encouraging playful suspension of disbelief by modeling the treatment of the bird as a real, live entity through our own actions, behaviours and language.

Our first configuration was intended to examine how participants would share private experiences with those around them. In this system configuration, participants interacted with the bird via a handheld telephone handset. Our intention was to create an asymmetric interface in which the bird’s audible content was known only to the person in possession of the handset who could then choose how to communicate his/her unique experience with his/her companions. This configuration enabled us to elicit a variety of participant interactions, allowing us to observe how they shared information amongst themselves as they experienced the installation. In order to better facilitate participant-led ‘performances’ with the work, an alternative configuration of the Nightingallery interface replaced the telephone handset with a conventional microphone, an interface with a conventional affordance more suitable for enabling participants to use the installation to perform for their peers.

Further Opportunities for HCI Investigation
Through our experiences with the humanaquarium and Nightingallery projects, we have had opportunity to observe how the participatory performance medium facilitates and encourages unusual and interesting social interactions in authentic public spaces. By designing performance interfaces that were sufficiently enticing, we had success in soliciting spontaneous participation in creative, improvisational play. The encounters with the performance interfaces happened in explicitly public settings, indicating that the appeal of taking part was tempting enough to overcome social obstacles such as shyness, stage fright, and social risk. As such, we feel that the participatory performance medium provides an interesting platform for observing the unique social interactions that arise from the particular demands of a scenario that requires participants to engage in improvisational, creative behaviors in full view of the onlooking public. To continue our trajectory of research, we suggest several other social phenomena that we plan to investigate through the design of future participatory performance pieces.
Moments of intimacy between participants in the Nightingallery project were evidenced by complex musical interactions that occasionally took place when participants were attuned to one another enough to ‘jam’ via the bird interface.

Our presence within the humanaquarium enclosure and our ability to actively connect with participants via eye contact and gesture could be seen as both reducing or alternatively increasing participants’ vulnerability – participants who wanted to take part had their contributions actively reinforced through our visible approval, while those who wished to hang back and observe may have felt guilty ignoring our efforts to solicit their interaction.

It was intriguing to observe how groups of participants negotiated territory and defined their personal space and control region upon the front screen of the humanaquarium interface.

**Intimacy**

During the course of performing the works we were fascinated by small moments of spontaneous intimacy that naturally arose. These moments were experienced either firsthand (shared between us – the performers – and participants) or observed (occurring between participants amongst themselves.) Due to the musical nature of both performances, intimacy was often manifested through moments of intuitive musical synchronicity. We found these spontaneous interpersonal connections inspiring, and would like to further pursue how to increase the frequency of such occurrences.

**Vulnerability**

We acknowledge that people who choose to actively take part in our performances are agreeing to place themselves in a socially vulnerable position, visibly exposed as they are to the scrutiny of others. We are interested in exploring how alternative configurations and conceptualizations of the participatory scenario can either ameliorate or conversely increase participants’ perceived vulnerability – both outcomes providing potential avenues for investigatory and aesthetic exploration.

**Social negotiations**

Demographics, social hierarchy, and familial relationships necessarily influence how peers relate to one another when taking part in collaborative activity. We are curious to explore further how social negotiations amongst peer groups influence collaboration and creative behavior in public space.

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Low Resolution Displays for Performative Interaction in Public Spaces

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Abstract
When interactive systems require users to "perform" in front of others, the experience of interacting dramatically changes. This "performative" dynamic can be purposefully exploited in the design and evaluation of interactive systems to create compelling experiences. In our work, we explore these issues using highly flexible low-resolution displays composed of strips of individually addressable LED lights called Pixel Strips. These low-resolution displays can take a wide variety of forms and can be deployed in many different settings. We pair these displays with depth sensors to add playful interactivity, whole body interaction, and proxemic interaction. Such a combination of flexible output and depth-based input can be used for a variety of playful and creative interfaces. In this paper, we describe some of the most promising directions made possible using this technology, such as ambient interfaces that create playful reactive experiences, visualize pedestrian traffic, and highlight social dynamics.

Author Keywords
Performative Interaction, Interaction in Public, Low Resolution Displays.

ACM Classification Keywords
H.5.2. Information interfaces and presentation: Input devices and strategies.
Introduction
Interaction in public places is an opportunity for users to express themselves and contribute to shared experiences in social settings. These exciting extensions to user experience in public have led to the creation of a huge variety of performative interfaces, such as the WaveWindow interface [7], the Worlds of Information large public display [6], and the Bridge project that allowed users to "walk on water" [3]. The technologies that support public interaction vary widely, from large public displays, proxemic and whole body interaction using depth and motion sensors, and large tangible interfaces. This position paper presents one approach to developing compelling interactions using arrays of individually addressable LED strips and depth cameras.

Pixel strips, as shown in Figure 1, are flexible strips of individually addressable LED lights that are controlled using a microcontroller. We add interactivity to these strips using a Kinect sensor to capture movement and proximity from users near to the pixel strip installation. This technology supports rapid prototyping and flexible installation, encouraging divergent designs and exploration of novel interactions. In this position paper, we describe some of the performative dynamics we seek to explore with this technology and some of the directions we are currently pursuing.

Interaction in Public
When interactive systems require users to "perform" in front of others, spectators that may be watching and users' perceptions of their own performances influence the experience of interacting. During interaction in public places, users will be constantly evaluating the feedback from spectators changing their behaviour based on spectators' reactions [5]. The experience of interacting in front of others can have a significant impact of the perceived enjoyment, acceptability, and usefulness of interactive systems. These issues are especially pronounced in systems that specifically exploit the presence of spectators, encourage extravagant interactions, and build experiences that purposefully put users in centre stage. Designers of such performative interfaces must consider how the visibility of the manipulations and the resulting effects work together to create an experience in public places [9].

There is a strong body of previous work that builds on sociological and anthropological foundations to explore the issues of performance and experience as part of an interface. This previous work varies in its theoretical foundations, the primary focus of inquiry, and the methodologies used when evaluating performative interactions in different settings. Our approach revolves around the dramaturgical metaphors of Goffman, where any action in a public space can be considered a performance of some kind [5]. This approach to "everyday performance" considers how we present ourselves to others in daily life, how our actions are like performances of our desired 'character,' or the impression we hope to create, and how we are constantly adjusting that performance as we gather feedback from others.

There is a wide variety of research that focuses on both spectators and performers through qualitative or ethnographic evaluations. Sheridan et al. describe how performance frames can be used to understand participation in digital live art performances [8]. That research revolves around the concept of "wittingness," where individuals' awareness of the performance frame influences how they participate in a performative experience. Gardair et al. looked at how performative spac-
es are defined for street performers, examining how passers-by transition into audience members in this setting [4]. Benford et al. also discuss the fluid relationship between audience members, witting or otherwise, and bystanders through a mobile performative game [1]. This project sought specifically to blur the boundaries of digital and physical aspects of the game to encourage performative activities in public places and implicate passers-by as unwitting participants.

Based on these previous works, we aim to explore the following key issues with our pixel strip installations.

- How can we capture and make use of unwitting performances?
- How do users discover and negotiate “interactive” versus “spectating” spaces?
- How can we create installations that support both performers and spectators?

**Pixel Strips for Performative Interaction**

Arrays of LED lights can create compelling interactive installations. Sato et al. used LEDs as pixels in a large-scale display at an airport departure lounge [10]. This installation, called “Constellation of Departure,” displayed the night sky above with visualizations of departing airplanes. Chandler et al. also explored the use of LED lights for “emergent displays” where LEDs were used to create displays of self-organising pixels with a flexible shape and density [2]. Such LED installations provide a high level of flexibility and creativity with often beautiful and high impact results.

We are currently working on rapid prototyping and exploring interactive possibilities of such low-resolution displays with proxemics and whole body interaction. Our low-resolution LED displays are made up of flexible strips of individually addressable LED lights, as shown in Figure 1. The LEDs are controlled using an mbed microcontroller. These flexible strips can be deployed in a variety of ways, such as creating grids of LED elements, bending and wrapping LED strips around large surfaces, or suspending 3D shapes in open spaces. We add interactivity to these displays using a Kinect for movement and proximity input.

**Interaction with Low Resolution Displays**

We are currently exploring several directions of research using these pixel strip installations that exploit different aspects of performative interaction and interaction in public. By combining flexible displays with whole body interaction, we aim to design action that can be subtle or extravagant, allows spectators to fluidly between different roles, and encourages interaction between users and plays with social structures. A basic one strip installation is shown in Figure 2.

**Reactive Playful Interfaces**

The pixel strips can be used to create basic interfaces that are reactive to movement in real-time with simple and playful interaction. In this setting, users can explore interactive boundaries and discover interactive elements in the installation simply by being present.

- React to position in front of display and distance away from display
- Encourage exploration of simple visualisations that respond immediately to presence
- Allow multiple users to explore the same functionalities together
Visualising Pedestrian Traffic

Where the previous interface provides reactive and “in the moment” interaction, we are also working on prototypes that provide a temporal experience and visualise traffic in front of the display over time. Through this installation we aim to gather unwitting performances and capture the curiosity of spectators.

- Visualise traffic in front of the display as glowing trails which fade over time
- Support both interaction by creating trails and spectating by watching trails
- Make passers-by aware of the lasting impression of their own traffic

Highlighting Social Dynamics

By employing proxemic interaction, low-resolution displays can also visualise social dynamics and encourage users to interact with each other. More sophisticated visualisations could reward collaborative actions and create visualisations from observable social dynamics.

- Create visualisations the only respond to interaction between users
- Create visualisations that respond to collective group action
- Create visualisations that single out users in a group

Conclusions

Pixel strips provide a powerful and creative platform for exploring performative interaction in public spaces. In our research, we are currently looking at how we can use low resolution LED displays to create simple and playful installations, capture unwitting performances, and support interaction around social dynamics.

References


Social Interaction with an Interactive Media Installation in a City Center

Abstract
In this workshop paper, we describe our experiences from a public trial, where a sculpture at Oulu city center was used as part of an interactive media installation. The media installation used the sculpture of a giant stone ball resting on a water fountain as a method of interaction. By rolling the stone, people could rotate a 3D model of Earth presented on a display next to the stone ball. During a public trial, approximately one hundred people interacted with the system, and we witnessed how it facilitated social interaction, education, and community cohesion.

Author Keywords
Tangible interaction; urban user interfaces; ubiquitous art; natural element user interfaces; public spaces interaction.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Weiser’s vision describes how computing interfaces become embedded to our physical world, and will disappear as when they integrate to the everyday life surrounding [6]. In our project, we sought to look at an urban space from a point of view, where we linked the
conventional constructions into an interactive, computational installation. In our City Mouse project we were interested in exploring how interactive media can be entwined to the tangible elements of urban spaces. Earlier research has reported that the use of natural materials such as water [4], ice [5] or soap bubbles [2] facilitate playfulness, and we sought to design the media installation along similar lines by using unconventional materials in the user interface, stone and water.

**Interactive Media Installation**

In autumn 2012, we organized a City Mouse media installation at the city center of Oulu, Finland. In the project, we utilized the Rotuaari ball sculpture, see Figure 1, which is a well-known landmark in the city center, and used commonly among the local people as a meeting point or when navigational instructions are given. The sculpture consists of a large stone ball of approximately one meter in diameter, see Figure 1. The stone ball rests in a spherical stone bowl that has been carefully carved to match the shape of the ball. Water is pumped into the bowl and forms a thin layer in between two stones, allowing the heavy granite ball to rotate when pushed. Our interactive installation uses the rolling of the giant stone ball as an input. By pushing the ball so that it rolls, the user(s) can rotate a 3D model of Earth that is visualized on a screen next to the sculpture (Figure 2). The rotation of the stone ball was tracked with an optical mouse (Logitech M90) placed directly on its side. The mouse was covered with transparent plastic bag and sealed within a box, which was placed and balanced to gently touch the wet granite ball.

Although the shape of a large ball is a relatively rarely used form factor among control devices, spherical user interfaces have explored earlier e.g. in Sphere project [1] and with volumetric displays [3]. A sphere is a well suited form factor for multiuser interaction as it allows 360 degree access to the system.
Facilitating Social Interaction and the Community
During the trial organized during one day in August 2012, approximately a hundred people interacted with the system. Altogether, the system was found playful and engaging, and especially the interaction with the large, heavyweight stone ball was perceived to bring a unique flavor into the user experience. However, our public trial led also to the following observations that were not directly linked with the interaction itself, presented in the following. We found out that our demo

- facilitated social interaction in situ
- was turned into educational material
- provoked expressions of community that related to the use of the existing public objects in the system.

Facilitating Social Interaction
The installation facilitated social interaction very well. People interacted with the ball simultaneously – sometimes just trying it out, but also to navigate together to see a certain location (typically their home country). Especially children were eager to play with the demo together. Also, the installation evoked social interaction that was not directly related to interacting with City Mouse. Both short and lengthy discussions were born at the installation. Some people started to comment where they had travelled, and tell their experiences with different countries or cultures.

Turning the Demo into Educational Material
Several times the installation was used as an educational material. Some parents encouraged children to find out Finland, where the demo took place, and which was the home country for most of the participants. In a family travelling together, parents showed the children where they had started their trip.
and where they were located now. In one family, the father stood by the display and pointed out different counties that were shown while the children rolled the giant ball, see Figure 3.

**Community, Ownership and Engagement**

Interestingly, a feeling of a community (of the people living in the city/area), or how they perceived the sculpture surroundings as their own (common) territory was mediated from the audience behavior. During the public trial we were addressed several times with questions and comments where the set-up was referred with an expression “our [sculpture]”, e.g. "What an Earth are you doing with our Ball?" Also, a number of comments referring to the sculpture in historical or temporal perspective, revealing that people passed by and paid attention to the place quite regularly: "Good that this [landmark] is finally used for something more, it has been pity that it just stands there”.

**Discussion**

When designing the media installation, our original focus was to investigate the tangible user interface and the use of materials with it. However, our experiment turned out to be interesting also for the social and behavioral aspects it provoked.

We believe that integrating something that was familiar and an integral part of the common urban space to the interactive system had a positive effect in catching the audience’s attention. It provoked curious reactions, and in our experience, also lowered the threshold to try out the interaction and to express opinions of the system. Our findings indicate that if people perceive that the interface or installation is “theirs”, they are more eager to try it out. We were surprised by the positive feedback of integrating the media installation into the already existing elements of the public space, and this encourages us to continue within this design direction.

**References**


Mediating Exposure in Public Interactions

Abstract
Mobile computing and public interactions together open up a new range of challenges in interaction design. To date a very gregarious model of interaction has been assumed. However, the public setting will invoke feelings of shyness and a desire to control the personal exposure associated with interactions. In this paper we discuss these issues and our initial tests of a system which affords a control beyond "engage or don’t engage".

Author Keywords
Mediating visibility, public interaction, commenting system

ACM Classification Keywords
H.5.2 [User Interfaces]; K.4.2 [Social Issues]

Introduction
Pervasive computing, both personal (especially mobile) and public – embedded in the world around us, has the potential to deliver many social benefits, through a more natural approach to computing which enables its benefits to be greater and more widely felt. However, this benefit requires more than universal access to data and computing devices – it requires significant social change. It is tempting to argue that pervasive computing must fit existing society without disruption or, conversely, that society should adapt to its surroundings. Instead, we
make a more complex argument: that while we may expect society to change, this change should be negotiated by the participants, each finding a place in which they are comfortable. If our new technology excludes parts of society or creates new barriers it has not been entirely successful.

In our recent work we have focussed on the issue of enabling participation through creating new, technological, comfort zones. In particular we are interested in information models and implementations that allow users to control presentation of self and mediate interactions, particularly in performative settings [1]. We are also interested in the sense of performance anxiety and shyness arising from the more immediate forms of interaction provided by pervasive computing. To do this we have explored modes of interaction which are not universally comfortable in applications which have the capacity to raise tensions through considering trust, comments, discussions, privacy and personal space. We then observe how the controls over comfort are used. We are not presenting the results of a large scale study here, but initial observations and prompts to the wider community to consider these issues.

Systems For Discussion
We have focussed on systems which allow discussion in the virtual to be connected with the physical world: commenting on what is around us. The idea of “giving feedback” online is well established and used, however the direct connection between a physical presence and that feedback is not. The in-situ nature presents some challenges:

- Hands are often busy with bags, drinks etc.
- When physically with others the discussion will often first be with those present rather than the wider world, although anecdotally we see many people using mobile devices when out with others.
- When others we know may be nearby, anonymity is reduced and creates a tension around appropriateness and feeling qualified to comment.
- Similarly, when the person whose work is being discussed is nearby, being seen to leave comments creates a social tension.

It is the concerns around being associated with what is said that we are interested in here. Can we provide sufficiently usable aids that allow users to prepare thoughts, and separate themselves from association with their comments? These questions of engagement and moderation of "public" are also raised in [2].

Our System
We have a system, “ShineUS”, for supporting discussion of physical artefacts, which explores how public people want to be about what they say. This system has benefited from past experience in public deployments in markets [5]. We expected that mediation of discussion via the virtual would have several effects:

- It provides a natural delay in which thoughts can be framed, widening the circle of discussion to those less confident about synchronous interaction.
- It provides a level of anonymity which allows people to say things they might not say face to face.
- It provides a degree of permanence and visibility to a discussion which may affect the comfort of some users.
- The asynchrony may lead to interactions which would otherwise have been missed, due to time and space limits of the physical experience.
The system has a number of components:

1. A server, hosted at the University of Sussex, which provides web pages and stores all data.
2. QR codes placed by the artifacts, and also on “menus” elsewhere in the deployment environment.
3. A projector to provide a very public visualisation of the live comments.
4. Users’ mobile devices, acting as code readers, comment input and comment reading devices. This provides a more personal visualisation of comments.
5. Project team members with tablet devices to explain and demonstrate the system.

The mobile version of the system is a mobile-friendly website, rather than an application – so can be run on a wide variety of devices with minimal setup complexity.

Instructions were provided in the venue for loading a QR reader app for iPhone and Android devices. A typical use case would be:

1. Identify item to discuss by QR code or on web site
2. Register / login if the user hasn’t done so before. There was a short questionnaire upon registering to gather demographic and confidence measures.
3. The user makes a comment, as shown in figures 2,3,4. The ability to reply supports discussion.
4. When confirming the post the user chooses visibility control settings, including show/hide nickname; send to nearby projector and on web / just show on web; delay appearance of comment; copy post to Twitter / Facebook account (if accounts linked).
5. The comments on the projector automatically cycle through recent public posts to the various tags to prompt people to look at what is being said and engage in the discussion. An example of a projection screen can be seen in figures 5,1.

The visibility controls are seeded with a default and the last settings are remembered, but each post has its own visibility settings allowing users to vary according to the post without affecting existing posts. The defaults are chosen round-robin from a limited set, giving a mix of default degrees of exposure.

Unlike many systems which focus on expressive power and how people arrange their lives in large scale social networks, e.g. [3], we are considering a system which has to be simple to understand and use through a smartphone and does not seek to be a means to describe yourself – but to describe thoughts in relation to objects under discussion, art in this case. However, the very public nature of the system and the use of nicknames, which for some users contained real names, does require some visibility control.

**Deployment Lessons**

We deployed the system at an art exhibition, part of “white night”[1] where it was presented as a system for discussing the art. The event was in the evening, lasting 7 hours, with 11 pieces of visual and performance art requiring a mix of interactive and observational engagement.

Google analytics reported 181 total unique visitors to the system during the night, of which 131 were via QR scans, 20 following Facebook or Twitter links and 1 following a web search. 26 users signed up, 21 of whom posted at least one comment. These numbers included 2 users

http://www.whitenightnuitblanche.com/brighton/events/like-shadows-a-celebration-of-shyness/
involved in the study who seeded the discussions, illustrated the use of the system and, with the aid of tablets, provided advice to users who needed it. The seeding process allowed users to observe the system, rather than forcing participation. The “seeding” users and all their posts are excluded in the discussion below. Of the 19 participating users, the majority were between 25 and 40 years old and the male:female ratio was 2:1, just one user not specifying a reply to these questions. Anecdotally we observed that few users had QR readers already installed on their phones and we heard several comments like “I’ve seen these [QR codes] in magazines but never used them”. While QR codes may be commonplace in the pervasive / internet of things research world, their use by the general public in the UK is not. Further, a few people noted that they didn’t think their phones were up to the web browsing part of engagement.

A similar system was deployed at a computer science conference, as a system for commenting on posters and demonstrations, but despite greater familiarity with the technology was less heavily used: 9 users registered and 6 commented with a total of 7 comments.

Comments Made
Of the 30 comments made at the gallery, 17 are made about the three most talked about pieces, the rest prompting just 1, 2 or 3 comments. The time between each user’s first and last comment was consistently less than an hour – which ties in with the flow of people through the venue, although comments were made throughout the evening.

The users were general public at an art event and had little sense of community or general connection to each other, and many would have been under the influence of alcohol. 14 of the users said that they felt at least reasonably confident about commenting on art and 12 rated themselves between 0 and 3 on a 1 to 10 scale of “how shy do you feel today”. This context gave rise to a lack of concern about who read comments and we have observed that settings move towards more public comments – with only a few more sensitive comments made anonymously. This disconnection from the mass is also reflected in the lack of “replies”, although 2 comments refer to a previous comment (“don’t like to be a naysayer but...” and “lol”) and 2 refer to other people present (e.g. “I don’t think my boyfriend is ever going to leave this room...”). These interactive comments were made about pieces with fewer comments, not just the busy ones.

We saw a reluctance to engage with our system at the academic conference, which (having spoken to some participants informally) arises from a combination of two effects: First, that hands were often full – with a bags, drinks etc. Second, that in both cases the act of scanning the tag was much more visible to the stallholder or poster presenter than it was to the gallery artist, and that they were available for direct interaction. The virtual was both less necessary and socially awkward – not all interactions need a near-synchronous virtual counterpart.

Use of Visibility Controls
In the art gallery deployment, we saw 30 comments from 19 users. 11 comments were more public than the default (not anonymous and/or projected), 12 were default and public, 7 were default not public, and 1 was less public than the default. 2 people chose not to have their comments on the projector. In terms of delay, 12 were less than the default (although in one case this was reduced from 10 to 2 minutes), and 18 had default not delayed. Critical or personal comments do not seem to have been
treated differently from more positive comments.

At the academic conference we saw 7 comments from 6 users. 3 comments were more public than the default, 2 were default and public, 1 was default not public, and 1 was less public than the default. No one chose not to have their comment on the projector. In terms of delay, 4 comments were less delayed than the default, 2 default not delayed, and 1 was longer than the default. 2 comments might have been interpreted as mildly critical, one was anonymous by default but the delay was reduced the other changed from display name and zero delay to anonymous and 2 minutes delay.

So, in both cases the majority opted for a public and immediate presentation, but in both cases a few users wished to reduce their exposure either by greater anonymity, by avoiding the projector or by using some delay between input and display being public.

Discussion

In these deployments the general behaviour was not to make great use of visibility reducing facilities – but this behaviour was not exclusive. Some users chose to limit their exposure, either generally or for some posts. Other users, in verbal interaction, were clearly reluctant to engage, with some comments suggesting a fear of exposing their perceived incompetence with technology. The generally public mood reflects a combination of influences: the very transient nature of participation, despite the public interaction; the low level of personal data involved, particularly with the short-lived interactions. We might also speculate that the widespread use of social media by the participants and the night-time setting also made users relax about their exposure. Key to more substantial results will be longer duration and more widely used deployments or this or similar systems. This will enable understanding around asynchronous co-presence [4] to develop and social conventions of variable public exposure to develop.

Conclusions

Balancing real-world interactions and virtual interactions is far from seamless. Based on our sample, people’s preferences in this regard do vary – between people, places and individual interactions. This variation can be extended to many settings and users – “we are all different”. It would be interesting to explore this mediation of exposure through further systems deployments.

Acknowledgements

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References

Social Devices as a New Type of Social System: Enjoyable or Embarrassing Experiences?

Abstract
The concept of Social Devices has been proposed to increase and improve interactions between people and their mobile devices. In specific, Social Devices are mobile phones that interact with each other in order to proactively trigger interaction between co-located users in social situations. Scenarios of Social Devices include situations where the devices speak their suggestions in the public spaces. The users use body movements and spatial gestures to communicate with the devices and with the co-located users. These modalities make interaction audible and visible to people around the users. Even though this kind of interaction provides means for enjoyable experiences of surprise and connectedness, there may be negative experiences such as embarrassment and intrusion of privacy related to the public interactions. This paper discusses this new type of “social system” and how the public interactions with Social Devices may be made acceptable in the future implementations of the concept.

Author Keywords
Social Devices, Mobile Interactions, Public Spaces, User Experience, User Acceptance

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**Introduction**

Mobile phones have been developed to support remote communication between people. Smart phones are also used for entertainment. People may also use their mobile phone as a way to escape from face-to-face interaction with each other. This behavior may lead to the phenomenon of being “alone together” [9][5]. Social Devices are smart phones that can trigger interactions between co-located people [6] by commenting other people’s activities or suggesting new interactions between devices and people.

Social Devices lean on proxemic interactions [1], that is, proximity- and orientation-based interaction. When people come into the vicinity of each other, and the position of the device is “receptive”, interactions may be triggered by the Social Devices. To make interaction natural and enjoyable, Social Devices can support many interaction modalities. They use interaction modalities of speech and bodily interactions, in specific spatial gestures [10], in addition to the traditional mobile interaction through a GUI.

The scenarios of Social Devices are envisioned to include a wide variety of situations and social contexts, e.g. cafes, offices, airports, parking lots, schools, and so on. Most, if not all, of the scenarios take place in semi-public or public situations. This means that the social context includes more or less unknown people, i.e. strangers of various kinds. The usage situations may thus promote user experiences of connectedness, surprise and fun. However, the public situations in which Social Devices are used may give rise to concerns or hindrances for the acceptance of such interactions, for example because of embarrassment.

In this position paper, we discuss the types of experiences which Social Devices are expected to offer, and the factors which may cause hindrances for using Social Devices in public spaces. We do this by presenting a sample of scenarios for Social Devices, discussing the experience types and potential concerns. We conclude by discussing the role of Social Devices as part of a new type of “social system” formed of the devices and their users, as well as the people who happen to be the spectators of the public use.

**Scenarios of Social Devices**

We have created 25 scenarios for Social Devices in three focus group sessions with potential users. The scenarios span from sharing personal location history or application data to hosting a quiz or summarizing a conversation. While many of the scenarios are expected to concern users who are already familiar with each other, some of the scenarios help people to find co-located strangers who happen to have certain common interests with them, e.g.

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**Figure 1.** Social Devices support co-located, proxemic interactions between people through the mobile devices [10].

Social Devices support co-located, proxemic interactions between people through the mobile devices [10].

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Experiencing Interactivity in Public Spaces (EIPS) workshop proceedings CHI'13
liking a certain underground band. In the following, we explain three Social Device scenarios with different contexts of use and varying amount of unfamiliar spectators.

**Friend request in a parking lot**: Two acquaintances meet in a parking lot of a grocery store and the devices suggest friendship in social media.
- Social context: A public place outdoors with many strangers around.
- Examples of potential interactions in the scenario: One of the device talks to the other by suggesting friendship. The other user “nods” with the device as a sign for accepting the friend request.

**Searching for friends in a restaurant**: The phone is used to search for friends in a familiar restaurant.
- Social context: A semi-public place with some strangers and potentially some familiar people.
- Examples of potential interactions in the scenario: The user spatially scans the area with the device to find friends. Once a friend is found, the device speaks up the name of the person. The user can gesture a “come here” gesture to the friend, whose device speaks out the invitation to join the person.

**Betting at a friend’s house**: Making bets with friends about a game on television at a friend’s house.
- Social context: A familiar environment with only familiar people around.
- Examples of potential interactions in the scenario: Devices give suggestions for betting. Users swing up or down their devices to raise or lower the bets, turning screen down to exit the bet.

### Types of User Experiences and Potential Hindrances of Acceptance

In Table 1, we present potential user experiences and hindrances for the acceptance of Social Devices in the light of the three scenarios presented in the previous section.

<table>
<thead>
<tr>
<th>Social Device scenario</th>
<th>Positive user experiences</th>
<th>Hindrances</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friend request in the parking lot</td>
<td>Delight, connectedness, pride, surprise</td>
<td>Embarrassment of being rejected or having to turn down the friend invitation; Embarrassment of other people hearing the speech and seeing the gestures; Concern of lost privacy</td>
</tr>
<tr>
<td>Searching for friends in the restaurant</td>
<td>Curiosity, surprise, connectedness, awareness</td>
<td>Disappointment for not finding anyone; Embarrassment of public gesturing; Concern of lost privacy</td>
</tr>
<tr>
<td>Betting at a friend’s house</td>
<td>Excitement, competition, connectedness</td>
<td>Uncertainty about the correctness of money-related actions performed by gestures</td>
</tr>
</tbody>
</table>

**Table 1.** Potential positive user experiences and hindrances in three selected Social Device Scenarios.

In general, the positive user experiences in all scenarios relate to some form of connectedness between people. The focus is more on supporting the users’ “be-goals” or hedonic experiences in addition to pragmatic ones [4]. This is emphasized, as the whole idea of Social Devices is related to making people be in contact with each other. Depending on the main motivation of usage, there may be additional positive
experiences, such as curiosity of looking for other users, delight of finding people, excitement of competition, and surprise.

The social context has the major effect on the potential hindrances of gaining positive user experiences with Social devices. Public embarrassment may be the most prominent hindrance [2] for the use of Social Devices through speech and spatial gesturing. However, other hindrances may arise from the perceived (and real) inefficiency of using Social Devices, as well as from the inopportune moments of the interactions.

**Discussion: Towards a New Type of Social System**

We envision the future of Social Devices to form a new type of social system where the devices, their users and other people (the spectators) in the social context interact with each other directly and through the devices. In the future, there may also be smart objects placed in the environment which become active participants in the social system. This kind of system resembles the Internet of Things (IoT) paradigm [3], by focusing not only on the connection and communication between objects but also by increasing connectedness among people (see Figure 2).

The main users of the Social Devices are the active human participants who are ready and willing to participate in this system. The secondary users are the spectator who are uncertain about this system and mostly passive and mostly just observe other participants in this system. An important aspect in this regard is to make social devices appear useful, acceptable and interesting also from the spectators’ points of view. This might facilitate the adoption of the new technology for such secondary users. Furthermore, social norms need to evolve for this social system to become acceptable (e.g. respectfulness and reciprocity as in any interpersonal interaction). People need to get accustomed to the smart and (pro)active devices and gesturing people. This may happen in the long run as long as both the devices and people act “politely” in the given social contexts.

![Figure 2: The new type of social system formed by the people, the Social Devices, the spectators, and smart objects in the environment.](image)

We believe there is great potential for enjoyable experiences with Social Devices in both semi-public and public spaces. There are bound to be cultural and individual differences in how people experience the new types of interactions, for example the embarrassment of various kinds of public actions. There needs to be some regulations of the context in which Social Devices can be used (e.g. not in church or school classes) but in most places Social Devices can trigger new social interactions and hence, increase and improve human connectedness.
In order to make such social system enjoyable and acceptable, the following things need to be implemented:

- User profiles that define when and where users are willing to take part in the social interactions
- Contextual and activity awareness in order to make good estimates when it is appropriate for the system to initiate actions.
- Social protocols built in to the interaction sequences of Social Devices which take into account the social context and privacy protection
- Natural interaction paradigms for smart environments; acceptable spatial gestures [8] and alternative interaction modalities
- A common ‘vocabulary’ for gestural and proxemic interactions: universal types of input that mean the same thing in different scenarios.
- Ways for inclusion; allowing the spectators to easily join the interactions with Social Devices (according to the various design strategies for spectator experience, see [7])

In our future work we will design multimodal interaction techniques and implement prototypes of Social Devices in a project funded by Academy of Finland in 2013-2015, CoSMo – Co-Located User Interaction through Social Mobile Devices. We will also conduct user studies in real contexts of use to gain empirical understanding of how to ensure the social acceptance of such new social system.

References
Blobulous: Computers As Social Actors

Abstract
Public interaction experiences are becoming ubiquitous recently, however, interaction is usually limited to broadcasting and the actual experience not very rich. Especially social connectedness and bonding are important aspects of public interaction that are often overlooked. This paper reports on research investigating how a publicly displayed application can improve social connectedness by acting in a socially accepted way. Blobulous is a novel interactive installation that interacts with participants through projected avatars, which react to the participants’ movement and body signals. A functional prototype was implemented and evaluated.

Author Keywords
Interactive Installation; Public Display; Social Connectedness; Social Actorship; Computers as Social Actors

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
Public displays are effective in addressing multiple people and the same time aim at engaging bystanders, people passing by and others for a certain cause. While the use for advertisements, entertainment and promo-
tion is quite far-spread, the usual modus operandi of a single display is to engage people as a single person in a 1:1 message. A second drawback is the limited interaction space for people “using” a public display: messages are mostly unidirectional and there is a little that a person can actually do to be engaged in a richer interaction than simple information broadcast.

This work reports the research that aims at using public displays or installations to address multiple (previously unconnected) people at the same time and increase the level of social connectedness among them. The main challenge is that the public installation therefore acts as a social actor, a socially acceptable participant in a social multi-user setting. Part of this research is also to investigate whether computers (controlling the public installation) can indeed act as a social actor and improve social connectedness. “Social actor”, in general ICT uses, was developed into a conceptualization model through a series of empirical studies. There are five dimensions in the conceptualization of a social actor: affiliations, environments, interactions, identities and temporalities [1]. Social connectedness also stands out to be a very important psychological feeling that links to personal health and well-being [2].

Related work
In the field of HCI, computers are considered to be able to handle social tasks and tend to be treated like humans [3]. From these cases, social connectedness stands out to be a very important psychological feeling that links to personal health and wellbeing [2]. There is a growing community around public display and large-scale installations, and social interaction of their users, which is picked up by user-dedicated devices such as RFID tags and mobile phones [4-6]. In the case of Blobulous, an interactive installation is combined with bio signals, i.e., the heart rate, which other research also consider as a reliable and effective bio signal implemented as a type of communication between people [7, 8].

Blobulous system
Blobulous is a novel interactive installation (see Fig. 1 for example settings and Fig. 2 for system overview) that interacts with participants through projected avatars, which react to the participants’ movement and body signals. Blobulous uses a large (possible public) display to show abstract avatars, blobs of dots – therefore the name “Blobulous”, one for each participant and moving around slowly. The movement of the avatars is connected to the participant’s movement in the space in front of the display. The second mapping involved in the installation is from a participant’s heart rate to the color of his or her avatar. The mapped colors range from blue (cold, low engagement) to red (warm, high engagement).

The Blobulous system consists of four parts: (1) Wireless heart rate sensors capture and send heart rate
data from users to a central instance, (2) a central instance, including a receiver and a visual program, receives data from users and derives avatar behaviors represented as visuals on the projected screen, (3) a projector connected to the central instance, and (4) a Zigbee network, which handles communication between sensors and the central instance.

**Evaluation**

The objective of evaluating the *Blobulous* system is to show an improvement of social connectedness among participants. Social connectedness is measured by means of a questionnaire that has been derived from Social Connectedness Scale Revised (SCS_R) questionnaire [9]. The hypothesis of the user test is straightforward: *Blobulous, a Social Actor, improves the feeling of social connectedness among its participants.*

**Experiment setup**

In order to evaluate the feeling of social connectedness of people while interacting with each other, it is better to include a group dynamics factor in the evaluation. 21 (14 male, 7 female) participants were recruited online and randomly divided into 7 groups according to their time preference. So, in most of the groups, participants did not know each other before the experiment. Users’ backgrounds were distributed to Industrial Design (7), Electrical Engineering (4), Computer Science (3), Automotive/Logistics (3), Biomedical (2), Architecture (1), and Business (1).

Before coming to the experiment, participants were requested to answer the questionnaire to measure their initial level of social connectedness. During the experiment, this measure is repeated at the end of sessions 1 and 2. In the experiment, participants as a group were asked to perform three sessions: the first two sessions were planned to study social connectedness, the final one is so see how people can interact with *Blobulous*. Experiments were carried out following the two protocols shown in Table 1 to avoid a direction effect in the evaluation.

<table>
<thead>
<tr>
<th>Session</th>
<th>Protocol 1</th>
<th>Protocol 2</th>
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<tbody>
<tr>
<td>Session 1</td>
<td>A</td>
<td>B</td>
</tr>
<tr>
<td>Session 2</td>
<td>B</td>
<td>A</td>
</tr>
<tr>
<td>Session 3</td>
<td>Brainstorm &amp; Demo</td>
<td></td>
</tr>
</tbody>
</table>

A: Random Blobulous
B: Interactive Blobulous

**Table 1. Evaluation protocols**

*Fig. 3. Experiment room with a) projection screen, b) heart rate sensors, and c) central control instance.*

In both conditions A and B (Tab. 1), participants were asked to watch and explore the visuals projected on the wall (Fig. 3a) while wearing the sensor (Fig. 3b) and then have a short discussion about what they perceive from the visuals. Heart rate data was streaming automatically by the prototype while movement data was manually controlled via an Apple iPad using touchOSC [10] (Wizard of Oz) (Fig. 3c).
Only afterwards, in the demo session, participants were explained details about the functionality of Blobulous, and then asked to come up with some ideas and try to demonstrate the ideas together with Blobulous. All sessions were recorded for later video analysis. The experiment room was prepared with a large display on the wall, an interaction space in front of the display, and an experiment control area (depicted at the bottom of Fig. 3).

Methodology

A video analysis was proposed to follow up psychometric test of social connectedness to investigate and capture social behaviors in real-time that might link to social connectedness but could not be captured by questionnaires. Therefore, the evaluation was carried out in two steps:

Firstly, the Social Connectedness Scale Revised (SCS_R) questionnaire [9] was chosen to evaluate the level of social connectedness of participants in this study. SCS-R consists of 20 items (10 positive and 10 negative). The negatively worded items are reverse scored and summed with the positively worded items to create a scale score with a possible range from 20 to 120. Then, the mean score with a possible range from 1 to 6 is calculated by dividing the total scale score by 20 (or 20 scale items). A higher score on the SCS-R indicates a stronger feeling of social connectedness.

Secondly, the video analysis was carried out to check the feeling of social connectedness in conditions A and B. An observation scheme with behaviors and scores was developed to compare between conditions A and B.

Experiment results

SCS-R was used to study if there is an improvement or difference in the feeling of social connectedness of participants while interacting with the system. A repeated measures ANOVA with a Greenhouse-Geisser correction determined that the mean SCS_R score differed statistically significantly between different time points (F(1.484, 8.107) = 3.791, P < 0.046). Post hoc tests using the Bonferroni correction revealed that there is a slight reduction in the SCS_R score when bringing people from their own setting to a social setting or testing environment (M = 4.21 vs. M = 4.09, respectively), which was not statistically significant (P = 1). However, the SCS_R score had been improved after the interactive session with Blobulous (M = 4.68), which was statistically significantly different to the random session without Blobulous (P = 0.002) (Fig. 4). Therefore, it can be concluded that the Blobulous prototype elicits a statistically significant improvement in SCS_R score or the feeling of social connectedness of people but only in certain social contexts.

The internal reliabilities on the SCS_R questionnaire from pre-test, random and interactive condition had been found to be good (α = 0.936, 0.756, 0.751, respectively). Strangely, there were slight drops in the alpha values between the testing and pre-test conditions. This can have resulted from the fact that the pretest participants were at their own places while answering the SCS_R questionnaire, but during the test they were in a controlled room.
Results

The Blobulous prototype was designed to act as a social actor, specifically to improve social connectedness between people. Blobulous draws great attention from users due to its colorful appearances and lively movements. It also raises social awareness between people while they are together and informs them about individuals’ and the group’s condition. With those effects, Blobulous makes people talk about it, about each other and sometimes they try to understand Blobulous and interact with it. As a system with a physiological connection between humans and computers, Blobulous has more impact on social interaction than one without physiological connection: The experiment results showed a significant difference in the level of social connectedness between the two testing conditions (random avatars and interactive, mapped avatars).

Most importantly, the study showed that while Blobulous was mediating social activities, peoples’ feelings of social connectedness were improved significantly (P = 0.002 – one way ANOVA).

The system needs to be further developed with the ability to act independently but not only mimicking to do so, which was a pragmatic design choice in this study. Also there are further experimental results such as AttrakDiff and a social connectedness survey, which deserve further dissemination.

References

Exploring spatial configurations and the roles of actors, spectators and passers-by in mediated public spaces

Abstract
This paper presents early findings of a pilot study 'in the wild' as part of our ongoing research 'Screens in the Wild'. It focuses on exploring social interactions and the dynamic spatial configurations mediated by an interactive public display captured during a community event. We observed social behavior and technologically mediated interactions by actors, spectators and passers-by in the 1) direct interaction space surrounding the displays, 2) the surrounding public space and 3) across spatial boundaries (the networked space) over time. We suggest that the properties of the spatial layout play a significant role in framing the type of interactions mediated through the networked displays.

Author Keywords
urban space; spatial configuration; public displays;

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design; Human Factors;

Introduction
The city is increasingly mediated through pervasive and emerging interactive digital technologies. We outlined previously, within the context of public displays, the need to consider more clearly the social, spatial and temporal properties of urban space to successfully implement public display interfaces (1). In this paper we aim to address 1) how public displays may influence the dynamic change of the performer role (actors, spectators and passers-by) and 2) how the building layout creates different interaction zones that influence the nature of the interactions. In order to explore these questions we conducted a pilot study 'in the wild' and observed simultaneous interactions with and around networked public displays and the wider spatial context. We explore the role of the building layout in...
facing the spatial relation of the performer to the display and the type of interaction zones and social activities it may support over time. In particular we focus on 1) the type of interactions (direct, wide, networked) and 2) social behavior (social learning, role play) of actors, spectators and passers-by. Our findings are based on observations through image and video capturing and note taking. We discuss these findings in regard to spatial relationships and stress the dynamic time based aspect of these configurations.

**Background research**

Extensive research has been done exploring the challenges when deploying public screens in urban space. The technical challenges of deploying display technology in urban space have been summarized in Lancaster (2). Mueller et al. (3) explored how to attract passers-by to public displays and what it needs to notice interactivity. Networked interactions that go artistic work by 'The Telectroscope' and in a larger context through 'Connected Cities' (4) interconnecting several European cities through an existing infrastructure of urban screens and media facades in public spaces. The role of space, social proximity and full body performative interactions in shared urban spaces have been addressed (5). Through introducing ‘urban HCI’ (6) the spatial aspects of urban media installations have been described. However, the background research presented has not addressed a number of highly significant aspects in particular the ones related to the dynamic nature of urban space (7) and their potential impact on the design of public displays. In this paper we will focus on the role of performers and how the spatial relationships framed through the building layout change dynamically during a community event in London.

**Setting the scene (The Mill)**

The Mill in the East London Borough of Waltham Forest was established in 2011 for the local community and by the local. It defines itself as a hub where various groups meet, residents can share information and services in a self-determined way. The Mill hosted a large event celebrating their first anniversary on September 6th 2012. As part of this occasion we promoted our public display. The event was announced as ‘family friendly celebrations’ from 4pm until 9pm. During this time the local community gathered and contributed through bringing their own food to share. Various activities for all age groups were offered such as music performances, exhibition or make-up sessions for kids.

**The context (the spatial layout)**

The façade of The Mill is divided into three display windows (Fig. 2) which attract passers-by for different reasons: Behind WD1 is an event space, WD2 includes the main entrance, provides the screen and is used as the communities notice board. WD3 shows the kids room and attracts with a colorful cardboard dinosaur. The screen is positioned on the left side next to the main entrance to The Mill behind the window (WD2). This part of the building’s front sits back from the façade and is roofed (Fig. 2; WD2). This position impacts the screen’s visibility and therefore defines the different interaction zones (Fig. 1). The buildings front is in line with other houses in the street. Between the façade and the pavement The Mill has an additional enclosed paved area, which is among other things furnished with bike stands and pot plants. This semi-public space has an impact on the spatial configurations (surrounding public space).
The mediator (networked screens)
As part of the ‘Screens in the Wild’ project we designed and deployed four networked interactive displays; two in East London (The Mill and Leytonstone) and two in Nottingham, UK. The screen hardware consists of a TV sized public display, which is fitted with a touch foil, speakers, web camera and IP night vision camera (1). The foil is attached to a display window and the screen and hardware is sitting in a case behind the shop front. Currently we are running three alternating applications on all four screens. In this paper we focus on ‘SoundShape’; an application which allows collaborative music making across all four screens through touching various pads with individual sounds. At any time there are four live video feeds implemented on the bottom of the screen showing the close space around each screen (networked space) (Fig. 3).

Pilot study
The aim of our pilot study was to 1) qualitatively observe actors, spectators and passers-by behavior and interactions during a community event and 2) to explore the spatial relation in regard to our public display and interaction zones, as framed through the layout.

Observations and image capturing
Over the course of the event (4pm – 9pm) two researchers were present at The Mill. Their tasks included observations through video, pictures and note taking, whilst attracting as little attention as possible and to become part of the social ecology of the event. Three researchers resided one at each of the other location. Their responsibility was to attract passers-by on their end to engage with users at The Mill across the networked video feed or simply react to the interactions triggered by performers at The Mill. One researcher assisted remotely with supervising the networked system.

Findings and discussions
Overall, this set up offered rich social, cultural and demographically diverse range of participating local citizens at The Mill, which provides an ideal foundation for deploying public displays. During the event our public display became part of the social fabric and was continuously used by various people taking part at the celebrations. The fact that we facilitated on an existing social infrastructure and special event allowed us to observe interactions without active involvement of the researchers or setting up signifiers or attractors. We were able to observe various activities around the screen (direct interaction space), either directly related to the screen, next to it or inside the building (surrounding public space) as well as through the networked screen to the other screen locations (networked space) (Fig.4).

Direct interaction space
This space (Fig.1: (8)) was continuously occupied by all age groups, whereas children entered this space more often, for a longer period of time and in a higher density compared to all other age groups. People in this space were mostly actors playing with the applications, smaller children not able yet to reach the screen and parents enabling toddlers to touch the screen (Fig. 6). The created sound played a less significant role in this zone whereas the visual attraction through the touch pads or the live video feed triggered performers actions.
**Surrounding public space**

This includes the inside of The Mill (visible through the big windows) as well as the semi-public space and the pavements on both sides of the street (Fig.1: (2)). In the space around the screen people, mostly grownups, were either watching the activities at the screen or chatting with one another (Fig. 1: (5)). Over time the spatial configuration changed (Fig. 5: (1,2,3,4)). This observation allowed us to capture interactions mediated by the screen, interactions not related to the screen and zones which are transient (pavement). In each of the identified zones performers are more likely to change their role from actors to spectators or passers-by. In this zone sound was more successful in attracting performer’s attention.

**Networked space**

Whereas at The Mill the screen was embedded in the activities of the celebrations and therefore additional attractors were not necessary, the researchers on the remote screens had to actively engage with passers-by to attract them to the screen, or had to engage themselves with performers at the Mill’s screen. Due to the small size of the live video feed on the bottom of each screen hardly any passers-by got directly attracted by performers interacting on the other displays. In the case of networked interactions through the ‘SoundShape’ application actors were keen to interact directly through the video feed with performers on the other displays as well as through ‘SoundShape’ (Fig. 3). Collaborative sound making triggered interesting interactions. Overall sound generated interest when people were in the public surrounding space, but it was sometimes less effective once people started interacting with and through the ‘SoundShape’ application.

**Social behavior and technology mediated interactions**

Constantly children were exploring new experiences the screen intended to provide or not (role play) such as trying to reach the video camera for the live video feed. After a while the same children lost interest and were
replaced by others of all age groups. Teenagers where showing children for instance where the live video camera is placed on the screen (social learning). Others were stepping on chairs to come closer to the speaker and microphone above the screen in order to make their voice heard to users on the connected screens (appropriation) (Fig. 6).

**Conclusion**

In this paper, we explored social interactions and related spatial configurations in a pilot study ‘in the wild’. We clearly identified simultaneous multi layered behavior and types of interactions (direct, surrounding, networked) in a given spatial setting. These differ in the ways they relate to the interaction zones framed through the spatial layout in which they are embedded and also in the ways in which the interactions are mediated through the public display. The observed spatial configurations revealed a dynamic interplay of performers and their changing roles when moving across different interaction zones. For further studies we are currently exploring social interactions and the spatial setting in between several networked public displays over a longer period of time. In particular, we want to explore how mediated encounters across the spatial boundaries can influence the type of interaction zones.

**Acknowledgements**

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Isolating the private from the public: reconsidering engagement in museums and galleries

Abstract
There has been a long-standing commitment within museums, galleries and science centres to deploy complex technologies to enhance engagement and participation amongst visitors. The design of these systems has proved highly challenging and tensions arise in enabling both, individual action as well as cooperation and collaboration. In this paper we draw on our recent studies to consider the problems and issues that arise in facilitating the private and the public, the individual and the collaborative, and its implications for the success of innovative systems in museums and galleries.

Author Keywords
museums; interaction; public; private; ecology; video-analysis

ACM Classification Keywords
H.5.3 Group and Organization Interfaces: Computer-supported cooperative work

General Terms
Human Factors
Introduction
Over the last decade or so, a wide range of novel technologies have been introduced into museums, art galleries and science centres. For the individual visitor, these have included mobile systems such as the audio guide, the PDA and the smart phone app to provide detailed information about exhibits. Meanwhile large public 'interactives' have been developed to allow several visitors to participate in experiences with and around artefacts [6]. So these can be used by members of the general public, techniques familiar to researchers in HCI have been incorporated into the design of such systems, including touch-screens, multi-user interfaces, image and gesture recognition. However, features in the design of these novel technologies can have unexpected consequences. Systems that are designed for use by an individual visitor can adversely impact the experience of other visitors to an exhibition, while systems intended to encourage co-participation fail to encourage cooperation and collaboration. In this paper we briefly discuss a number of attempts to introduce new technologies into museums and galleries, some were designed to support the individual visitor, others were aimed to encourage interaction between visitors. We will highlight features that either undermined or failed to facilitate the appropriate form of engagement. We will suggest that for public settings simple distinctions between the private and public or the individual and the collaborative are inappropriate and that we require more subtle and complex ways of differentiating participation and engagement in particular tasks and activities.

Background
The deployment of technology in museums, galleries and science centres raises a number of challenges for designers. Systems and devices need to be (1) robust to withstand extensive usage over long periods of time, (2) be "intuitive" to operate because they usually are deployed unstaffed; and (3) support a wide range of different kinds of users, of differing ages, familiarity with technology and expertise in the appropriate subject area. As these technologies are deployed in semi-public settings, often as part of an exhibition or themed gallery, they have to facilitate engagement with say particular objects, while enabling exploration. A broad range of techniques have been deployed as part of interactive exhibits and installations to try and meet these demands, including audio presentations and PDAs [8]; novel video techniques and projection systems [4]; gesture recognition [9], robot guides [10]; systems to support remote participation and collaboration [2] and mixed-reality systems [1]. However, even when careful attention is paid to the design of such systems they can have inadvertent consequences. Take the example of PDAs and audio guides where the provision of detailed information on a small device can undoubtedly enhance the engagement of an individual visitor and yet undermine co-participation, and disrupt the navigation of other visitors (Figure 1) [7]. Conversely techniques designed to support some form of collaboration can either be overlooked or fail to engender the appropriate form of engagement [6]. It may be worth considering a few examples of technologies introduced into the museum setting in a little more detail to reveal some of the challenges of developing systems in public settings, whether they were designed for the individual or for collaboration.

Figure 1: A visitor using a PDA in a modern art gallery
Transforming the Private and the Public

Like many Science Museums, the Science Museum in London is faced with the challenges of explaining complex matters to a wide range of visitors. When the Wellcome Wing was built to focus on contemporary issues regarding science and technology the curators worked with designers of innovative technologies to develop novel ‘interactives’ to engage visitors in scientific issues, most of which were the topic of recent debate, for example, climate change, genetics and identity. One kind of ‘interactive’ – the bloid – was designed to provide information and engage visitors in a number of tasks concerned with Bioscience. Each bloid is a large metal structure, with a networked computer embedded within it and operated through a touchscreen (see Figure 2).

The touchscreens in the bloids are set back within the casing offering the visitors privacy as they engage in activities like seeing how their face might appear if they changed sex. The size and position of the screens limited the number of by-standers with visual access to the screen. Companions will stand close by the user and huddle around the exhibit to attempt to participate in the activity. However, they rarely have sufficient access to the activity and the system to enable collaboration. Therefore, on having witnessed elements of the activity, when it is their turn, companions have an impoverished and unsatisfactory experience.

At about the same time, the Victoria and Albert Museum (V&A) in London also deployed touch-screen systems in their newly refurbished British Galleries (Figure 3). These touchscreens were typically placed on plinths alongside pieces of 18th and 19th century furniture and showed, for example, short video clips of ‘furniture in use’. Despite being more visible to colleagues, visitors rarely viewed the screens together. Rather they would engage in different activities, one of them viewing the video and voicing outloud about what they were seeing whilst their companion would simultaneously examine the original furniture. Although supporting a way of collaboratively exploring an exhibit together, the snippets of information they voiced were also available to others who were nearby, and would obtrude into their experience of other artefacts in the local environment.

Despite incorporating very similar touchscreen technologies the ways in which they were deployed seemed to engender different kinds of collaboration. The designers of the bloids were sensitive to the need of some visitors to engage with the system ‘privately’. However, this precluded other kinds of participation and engagement. However, the designers of the touchscreen system for the V&A Museum seemed to want to encourage collaboration between visitors and yet, perhaps not of the intrusive kind that could emerge. Both systems were carefully designed but when deployed into the setting raise challenges for designing artefacts in public spaces, whether these are for individual use or to engender forms of co-participation.

Creating public engagement

To investigate novel ways of facilitating, supporting, and even encouraging different forms of participation we have deployed a number of specially designed technological interventions in museums and galleries. These are typically low-tech assemblies made of wood, and sometimes augmented by conventional computer systems and CCTV technology.
The Drawing Machine, for example, deployed in the Royal Cornwall Museum was designed to enliven static objects displayed in glass-cases. Visitors were encouraged to move a drawing table in front of the object in the case and by drawing it (Figure 4) discover properties of exhibits and relationships between different parts of the installations. Visitors often arrive in pairs or small groups at the installation and one of them typically takes charge of the pen whilst the other(s) watch, help with, instruct and comment on the activity. As the visitor draws an object displayed in a glass case with the Drawing Machine others can see how the person is continuously comparing and contrasting the object in the case with their drawing. The Drawing Machine therefore engages not only the visitor doing the drawing with the original object but also other people who observe the activity and relate it to the exhibits in the case. People can see and make sense of the practices through which others create relationships between themselves and the Drawing Machine.

The ecologies of engagement
One difficulty with the design of technologies for museums has often been the provision of interfaces that can be accessed, visually and physically, by more than one person at a time, and to offer people who do not directly interact with the system opportunities to engage with and participate in, the activity.

At the Royal Observatory in Greenwich, London an interactive was deployed that had both physical and digital components. The 'Dice Exhibit' is used by placing dice of different sizes on a table where a pattern printed on their six sides is captured with a video camera triggering events on a screen in front of the exhibit (Figure 5). To the left of the table people find a manual that instructs them a number of ways in which the dice can be placed on the table to generate different kinds of astronomical phenomena shown on the screen in front.

Individuals arriving at the exhibit often overlook the manual on their left. But when visitors arrive in pairs and small groups they generate a division of labour with one of them moving the dice and one or two of the others using the instructions to comment on and help with the activity. The exhibit seems to engage all those standing near it, in different ways, in the activity. However, depending on where people come to stand at the exhibit the form of their engagement with the activity differs; those standing in the centre tend to adopt the role of 'principal user' who are in charge of moving the dice, those on the left read out the instructions in the manual and those on the right comment on the action or occasionally interfere with the position of the dice on the table. The local geography of the exhibits and the participants - the distribution of exhibit features, information resources and people - shapes how different forms of participation, both private and public emerge.

Discussion and Implications
The observations and findings from these and other studies we have been involved in suggest that in museum exhibitions the distinction between private and public activities is fluid and continually changing. Technologies that are designed to be used by the individual visitor often have consequences for others in the local environment. Visitors also may try to involve others in the use and experience of engaging with an exhibit. Designing for privacy in public settings can be
particularly problematic and challenging [5]. Perhaps, more importantly the difficulties of the deployment of technologies for collaboration in public settings are hindered by what can be accessible at any moment. Hence the success of such innovative technologies seems to be vulnerable to what might seem to be quite arbitrary factors. The order by which participants walk up to an exhibit, whether a visitor’s actions, their orientation and their emergent conduct can be tied to the operation of the 'interactive' or, as in one case we were involved in, whether the wires could be seen that linked two parts of an exhibit and so visitors could recognize that their seemingly private activities were interrelated to those of another [3]. Indeed, the success of collaborative artefacts can rest on what might be seen to be very short, barely visible, private activities; for example, at the Drawing Machine the movement of a co-participant's fingers or hand could be made sense of in relation to the emergent conduct and the features of an exhibit. Developers may consider a wide variety of novel techniques for engendering collaboration and interaction between participants in public settings, involving radical technologies, but the forms of participation that arise can be shaped and reconfigured by what in a very detailed way remains private and what is made noticeable and public.

References


Privacy Under Negotiation:
Participation in Public Interactive Art

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Abstract
Focusing on an artistic practice with a participatory approach, I believe that it is crucial for public interactive art practitioners to take into account of peoples’ interaction, both within and without the system. Reflecting on my experience with the public projects I produced at the Copenhagen Airport, Denmark and Moderna Galerija, in Ljubljana, Slovenia, I investigate how the concepts of public, privacy, intimacy and trust are constantly under negotiation between the artworks, the artist and the participants.

Author Keywords
Participatory art; interactive installation; public intervention; social event; privacy; participation and interaction

ACM Classification Keywords
J.5. Arts and Humanities

General Terms
Human Factors
"Some art aims directly at arousing the feeling; some art appeals to the feelings through the route of the intelligence. There is art that involves, that creates empathy. There is art that detaches, that provokes reflection.\[1\]" - Susan Sontag

On 23 December 2009, a large number of people were attending an interactive art event, Yes / No / Maybe, at Moderna Galerija, Ljubljana, Slovenia. An official call for participants was released through radio and press before the event date:

"[Yes/No/Maybe is] an interactive social art event developed by artist Nedine Kachornnamsong in residency at the Ljudmila laboratory and Museum of Transitory Art - MoTA. The Code.EP crew will flex up the event musically.

... [It] is an interactive installation and a social event which transports online dating elements into a physical setting. The displacement of virtuality into a physical setting is an attempt to dispense with the techno-utopian/dystopian view and a means to question the concept of humanity and its dualism politics.

Visitors will receive tags containing chips which will transmit signals that will influence the color of light in the environment near them. The colors are yellow, green and red and come from traffic lights; they reflect the level of the individuals' interest in socializing. The three fundamental principles of online dating (anonymity, declaring the level of interest, and the playful atmosphere) will be used to create a virtual situation in a real environment."

Because Yes/No/Maybe was a social and experimental project with a participatory art approach, we understood that without participants, our artwork would become an installation. Being uncertain how the public would respond to our idea of changing positions from virtual to physical and from private to public, we were hoping that at least half of the 75 electronic id tags we made would be taken by participants so there would be enough collected social interaction data for further research analysis. It was our intention to gain enough trust and interest from people to participate, therefore, we decided on the above press release message to let people know what kind of interaction they would be engaged with and still be intriguing by the image of science fiction.

However, on the evening of the event, the number of visitors greatly exceeded our expectations. All of the ID tags were given away within 40 minutes. And because Moderna Galerija, where the event took place, is a public institution and the project was publicly funded, we were not allowed to impose any restrictions to prevent people from participating. At the highest point, the estimated number of visitors had reached 300.

With only a quarter of all participants actually registered to the system, the data gathered was inadequate. In order to give an accurate lighting feedback, the mapping and comparing of flows and movements had to include everyone who was present at the event. While the work itself did not deliver the experience as it was planned, the press message was proven to be very successful in drawing a multitude of attendants. For that reason, the plan to further analyse and create a data visualization of the event's social interaction flow had to also be abandoned.

I.
Interactive art as it is known today has roots in the area of research and development, where technology was experimented with and computer-mediating ability
was over looked [2,3]. Its popularity has been dramatically increasing through the support of public/private funding as well as numerous annual exhibitions and international events, akin to SIGGRAPH and Prix Ars Electronica. Moving from R&D labs to galleries and then to public venues, interactive art has extended from merely being a responsive object to a pervasive system with large number of participants. Within this framework, the participation takes place when interactivity is no longer a one-to-one relationship, but instead involves a group of people in relation to each other and to conditions that correspond to their environment and social context [4]. It is the participatory aspect of public interactive work that I find fascinating.

II.

The main task of an interactive system producer is to create a system which will later become an agent that interacts with audiences on his/her/ze behalf [5]. Yet, a perfect system is nothing without a participant, and for the public interactive project a large number of participants is required. Hence, within this type of work, the interaction taking place before and during participation are equally vital as a part of the interplay between the work, the artist and/among participants. This is because an interactive system is a working set of equipments whereas interactive work is the working system with participants.

It was in the beginning of 2006, on the fifth day of my transit area field studies for a public intervention project aimed to create a sense of place at Copenhagen Airport, Kastrup, Denmark. In order to understand the transit area in its full daily cycle through an ethnographically-inspired method, I had just spent 24 hours on an observation round and slept overnight on a comfortable lounge chair in the airport’s sleeping zone.

The atmosphere was, and still is, organized, clean and sterile, filled with beautiful Scandinavian architecture, art and design with a touch of luxurious hardwood floor. Yet, I have never felt so anxious, so vulnerable from feeling both safe and unsafe.

On the previous day when I was at the gate making notes about people waiting for their boarding call, a group of undercover police asked a person not far way from me to stand up for a body search and baggage check. It was during the time of Danish newspaper Jyllands-Posten Muhammad cartoons controversy; the country was under several bomb threats and the fear of terrorist attacks was viral. The man who was chosen for a random security search became the centre of everyone’s attention. We were watching the whole procedure until the police left him without finding anything suspicious. He had done nothing wrong but was humiliated because he was singled out as different. Everyone felt uneasy. A couple of hours later I went hiding in the toilet simply to be at peace.

In the circumstance when everyone could be a threat and everyone could be a victim, my original project idea of creating a sense of place by using interactive installation to promote social interaction among passengers became problematic. The heightened level of security made a perfect construction of a full-on big brother system where one can intensively watch and be watched at the same time. The idea of implementing an interactive system at the time when the concept of social networking and its technology was unfamiliar to the mass public seems to be inappropriate. Since then, several what-if questions have arisen about the system itself in terms of security and trust. Because a public interactive installation is very much an open-ended project, there was no measurement that I could make in order to be fully in control of the outcome or people’s response to it, especially in such a stressful and
threatening condition. For that reason, a compromise between the original plan and the real situation needed to be made.

Still focused on social interaction as a subject to create sense of place, my aim was to establish a platform to promote a spatio-temporal communication between passengers. It was an intention to create the sense of place by letting the people memorize their experience from conducting social interaction. This was an opportunity for people to share their stories – a small moment to recognize and get to know the strangers [6].

To avoid any incident that might occur, an idea of digital interactive system was discarded. A concept of electronic message boards I had was transcribed into a low-tech solution of pencils and papers. These familiar tools of all ages and genders were selected to represent the sense of honesty and accessibility that is absent from most of the electronic device. The twelve posters, each attached with a pencil, were produced into 3 themes with a clear graphic indications and messages to instruct how participants should interact with them. For the placement, I decided to install them at the back of toilet doors to give participants a complete anonymity without any pressure from being watched. This meant that everyone who saw these paper notice boards were absolutely free to decide whether or not they will participate in the project and when they did, they were guarantee a full authority over their own action and interaction with other people.

The reception on the posters was surprisingly positive, there was no offensive message seen on the posters as it usually happens with normal toilet wall vandalism. Not only respond to the instruction on the poster, some users replied and commented on each other’s message. Mostly, people told about their traveling experience, gave advice, wished others a good journey, expressed their passion for their home country or whom they were in love with.

III.
Interactivity is a recurring process between actors – the feedback loop between them stimulates a spontaneous reaction – one’s activity is inconsistent with the other’s performance. When it comes to interactive art, a manipulation from audiences and a response from the artifact is essential. An artwork becomes an agent, which is waiting to be triggered by a user – without a participant’s input, the purpose and meaning of the piece remains concealed.
However, interacting with a public participatory project is not only a way of making oneself seen by other people but also to become a part of the work. By shifting one's position from private to public, an individual’s privacy is voluntarily given away. The experience I had from the previously mentioned projects seems to correspond with the notion of power of the gaze that refers to visibility as a trap for an enforcement of self-regulating and self-disciplining [7]. Therefore, I strongly believe that it is privacy not publicity which is at stake in the act of participation.

On that account, I see a public interactive project as a negotiation process of privacy and participation – an attempt in search of an optimal condition where artist and audiences agree to collaborate and together create the work. This interplay takes place through out the production, from planning to building, and until the end of the project. By focusing more on invisibility rather than visibility, artists can empower participants by shifting the terms of the offer in their participatory works. When obscurity is an exercise of one’s own volition, then privacy is not something to maintained or be held on but as something which is given. Thus, visibility in the context as such is no longer a trap but an empowerment.

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References
How Can Personalization Shape Social Action in Cultural Spaces?

Abstract
Museums and other cultural heritage spaces are social. Personalization, while accommodating diversity, tends to isolate because it focuses on the content delivered more than the sensorial experience of being in a place with others. We deconstruct the concept of personalization separating the content from the context to introduce social engagement through tangible interaction. We discuss the implications of designing for social interaction in cultural heritage, namely:

shaping the stories, the interaction and the ethics involved.

Author Keywords
Cultural heritage, personalization, tangible interaction, smart exhibits.

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. J.m. Computer applications: Miscellaneous.

Introduction
Personalization in cultural heritage is mostly synonymous of content adaptation, i.e. dynamically changing the amount or type of information conveyed to the single visitor to fit what the person likes and knows [2]. From mobiles [8] to the most recent augmented reality [3] the interaction is designed for the single individual. Personalization misses out on the fundamental fact that the context affects the experience more than the visitor’s cognitive and psychological status. A visit to a cultural heritage site is intrinsically social. Most likely people visit in a self-organized group (family, group of friends, class, couple) or a casual group (guided visits, treasure hunts), but even when visiting alone, in autonomy, individuals share/compete for the exhibition resources.
Attempts to bring together personalization with the social have taken advantage of projection facilities or situated public displays ([9], [4]). The potential of the social dimension has not been exploited in cultural heritage and it is still extremely limited, i.e. interacting with a multi-touch table [10].

A second observation is the nature of the interaction. Using a mobile application does not really engage people with the place and other people around them ([11][6]) and examples of personalization in spaces are still limited ([1][7]).

Exhibitions designed to engage the visitors into shared interactions have proved very effective even between strangers that just happened to be close to the same piece at the same time ([5][11]). These interactive pieces build upon the surprise triggered by the unexpected and the physical engagement that follows when trying to understand what happens. However, most of the time these are individual artistic expressions not intended to bring the visitors closer to and engaged with the heritage and its stories. They are limited to the performance.

A personally meaningful, sensorily rich, and socially expanded visitor experience with digital content can bridge the gap between digital collections and the specific social and material contexts in which heritage comes to matter. This is the purpose of our research.

We propose to use techniques developed in personalization to foster social interaction through direct engagement with smart exhibits, i.e. exhibits augmented with tangible interaction capabilities through sensors and actuators. The vision is that of a group of visitors that have to work together to unlock digital content embedded in tangibles. For example in a war museum a visitor can unlock the battlefield map on their diary only if they find the visitor that carries the enemy's diary, or a projection starts only if enough visitors are all marching with the same rhythm. The composition of the group and what they have to do varies dynamically on the bases of the context, e.g. where the interaction takes place, who is involved, when this happens and how. Personalization techniques provide the smart exhibits with autonomous behaviour controlled by a system of rules. The desired effect, however, must be planned through the design of some form of behaviour descriptors. This leads us to a critical question:

- How can designers plan and craft the interaction between group members or strangers that is implemented autonomously by the tangibles in place at a later stage?

Below we discuss the model we are developing in the meSch project (Fig. 1). The design of the experience is split into storytelling and interaction, and sequences the planning by the curator/designer with the program execution within the smart objects. We present two examples that illustrate the potential of this proposal and conclude with the open challenges to achieve such a delivery of content in cultural heritage with technology as an active agent among an active group.

**Orchestrating Tasks for Curators, Designers and the System**

Personalization research has so far bypassed the curators and directly supported the users by dynamically changing their visits [2]. In meSch we...
revisit this process to include human-supervised steps in the composition of the adaptive structures (Fig. 1). The inclusion of the curators and designers in defining the story and the interaction respectively can improve the quality of the visitor’s experience. The role of the computer becomes that of supporting the curator/designer in creating a good story/interaction and executing the performance as specified when the visitors interact with it.

**System-Assisted Content Selection**

While a curator is deciding on which story to tell the visitors, a recommender system can effectively support them by quickly filtering information from repositories and suggesting relevant material (Fig. 1, Layer 1). The recommender can discover new content to enrich the story under construction while facilitating the curator in learning about the content of the repositories.

**Scripting Adaptive Content**

For many, the expertise of the curator is what makes the experience of cultural heritage memorable. Curators must be free to compose their stories within the limit of what a personalization system can deliver. An authoring environment (Fig. 1 Layer 2) offering templates of effective stories gives curators the ability to define adaptive data structures; these are uploaded into the smart exhibits and automatically executed to deliver the story when the visitor interacts with the objects (Fig. 1, Layer 4).

Through pre-defined structures (or templates) that describe content adaptivity, curators author the content by drag-and-drop (Layer 2). Possible examples of adaptive narratives are: templates for coherent stories that dynamically adjust to multiple interaction, or narratives that use storytelling to connect different places (or points in space).

**Scripting Social Interactions Grounded in Context**

As meSch brings personalization into smart objects, how the smart objects react and adapt to the context of use is subject to author’s supervision (Layer 3). Authors explicitly connect points in the narrative threads with single-user or multi-user actions and situations that can occur at use time. Pre-defined templates for adaptive experience, as well as specific interaction rules, will be made available to authors. For example templates for fostering social situations (e.g., ten people to march synchronously), or object manipulation (e.g., wind up the radio to play the war bulletins), or object search (e.g. find your enemy to unlock the full story of the battle). The personalization to the context is complementary to the personalization of the content: an author can use multiple alternative narrative templates with the same context template and vice versa, the same narrative template is applied to multiple context templates. This distinction allows accommodating different physical abilities for the same story, e.g. energetic children will have to work harder on the objects to release the content than older visitors. While the narrative structure will be the same for younger and older, the experience structure will not.

**Object Intelligence**

The two combined “content” and “interaction” structures are then connected to specific input and output capabilities and loaded onto smart exhibits that will trigger automatic contextual personalization when used (Fig.1, Layer 4). The smart objects have a certain degree of autonomy to automatically resolve conflicts when alternative behaviors are possible, e.g. four
people following each a different story simultaneously reach a point, the decision on what will follow is based on content mediation with respect to the narrative threads currently followed by the four people.

**A scenario**

One of the three sites meSch will experiment with is a WWI fort that was dug starting from 1909 in the Alps. With a network of local museums and remains of the Great War in the Trentino area (Italy), the fort is part of the Italian National Museum of War, visited by over 40,000 people a year. The museum has specific educational programs adapted to the different learning, experiential, remembrance goals that are currently at the hearth of the educational agenda of curators. Four visitors groups are currently distinguished: children (7-10), junior (11-13) and senior school (14-17) as well as groups of elderly people and families.

In the meSch scenario young children will receive a map and a basket to “treasure hunt” smart exhibits in the shape of historical artifacts; Older children will receive a soldier’s pack, i.e. a replica of WWI bag, already filled with smart exhibits; Teenagers will receive a sensor-enriched tablet disguised as a captain diary; The elderly will receive a walking stick containing sensors, actuators and loudspeakers. The basket, the pack, the diary, and the stick monitor the movement of the visitor during the walk from the visitor’s center to the fort and inside it and deliver their content at different points. When inside the Forte the diary automatically initiates a quest for the hints or places that activate a piece of content in the diary; the walking stick has a movement and sound sensors that control the play of the reading of a soldier’s diary pages when the stick is still and the voice level is low as to not interrupt conversations. The soldiers’ pack needs more people to be unlocked: the members of the group have received a soldier’s tag each. As they walk all together in line inside the tunnels in the fort, as marching troops, images of soldiers in the trenches are projected on the walls, with men falling one by one. If they stop and sit in the middle quietly, they will be able to hear stories of the many how died in the tranches.

**Challenges for interaction design**

Besides the technical challenges this project poses, there are interaction design considerations that we need to address.

We need to identify a set of narrative structures effective in telling compelling stories but generic enough to cover multiple situations to allow the flexibility that personalization needs, e.g. develop in time and space by means of distinct snippets. Examples can be a structure suitable for families or classes where part of the content is missing and delivered by the parent or the teacher while the system complements additional information. An evocative template based on noise and sound aiming at rising emotion instead of learning, or a narrative structure that requires the visitor to input, for example, the answer to a quiz. The system should also be equipped with the mediation rules required when multiple narrative threads merge.

The second challenge is to define the vocabulary of actions to be used as building blocks for more complex interactions and how these map to the narrative structure. The marching line or the treasure hunt are examples of actions that trigger content. Designers should also consider the need for rules of progressive
release, e.g. after two failures the content is released anyway, to avoid frustrating the visitors.

A further reflection related to ethics and the implication of forcing people to do things. There are positive cases of strangers willingly collaborating to make the exhibit work ([11][5]), however it is quite a different matter to force visitors to do so. Similarly, if the structure assumes the visitor adopts a character, e.g. the captain's diary, we must be aware of the possible emotional implications as not everyone likes to be "the bad guy". How acceptable this is is a matter for research.

Finally as the goal is to create compelling stories in cultural heritage settings via personalization and engagement we need to clarify what is the implication of a system that has a degree of autonomy and decisional power. How much this is acceptable to both the curators (the exhaustive control of the content as delivered may not be possible) and the visitors (an object telling them what to do next) may vary and needs assessment in real settings.

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References
Liberating Public Cameras

Abstract
Our work examines the potential in repurposing surveillance cameras as a utility for everyday use by the public. We built and staged a camera-based experience in a public square—Brooklyn Blooms—and are applying lessons learned from this first installation to a multi-camera installation at a science center. In this paper we give an overview of our approach and insights from this work in progress.

Author Keywords
Surveillance cameras, public interaction, movement-based interaction

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Human factors; design.

Introduction
Like others in this workshop, we are interested in public spaces as an emerging terrain for HCI research and design practice [1, 4, 8, 10]. In particular, we are interested in repurposing surveillance cameras, transforming them from a privately maintained and monitored tool for security into a public utility,
accessible for myriad public uses. We would like to
give passers-by the means and incentive to interact
with and through these public cameras for both
practical and fanciful purposes.

Much has been made in public discourse of the ‘big
brother’ qualities of the increasing presence of these
cameras [3], which record us and do not share back—
even inspiring artists to create forms of camera
camouflage [7]. The rise of good quality video cameras
built into smart phones has made people much more
attuned to the collection of video streams and the
sharing/recasting of such streams, which suggests that
now is a time when the public could be ready to make
use of additional data streams from public cameras in
interesting and fruitful ways.

Now that many surveillance cameras are IP-based with
streams traveling in an un-encrypted fashion, there are
not major technical reasons why they could not be
repurposed so that their video streams were publicly
accessible. Other technologies that were initially in the
security and safety domain (e.g. the Internet and GPS
technology which was funded by DARPA) have made
the transition to public utility, over time. Our project
focuses upon making steps toward and exploring the
implications of this end goal.

Artists have been repurposing public cameras for some
time now—a well-known example is the Surveillance
Camera Players [12] a group formed in 1996 in New
York City, which staged plays using surveillance
cameras in subways and other locations, and which is
still active in monitoring surveillance camera abuses
and issues. In the last 2-4 years, advertisers have
begun to stage interactive installations that make use
of public cameras as well. For example, Converse
launched a campaign called ‘Pro Streets’ which set up
cameras in public areas where people could come and
show off dance moves or other athletic prowess, hoping
to be shown on the main Converse website [2].
Advertisers have also capitalized on the ‘caught
unawares’ impromptu feel of public camera footage to

There are many design directions to take in terms of
making use of public camera video streams. Our focus
has been on repurposing cameras to support social
interaction and enhance a sense of community and
public safety. Ideally, we want to transform interaction
with such cameras from furtive isolated glances by
individuals who may feel singled out and under
suspicion, to an opportunity to interact and feel a
stronger sense of community and connection and
empowerment.

Phase One: Brooklyn Blooms
In the first year of this project, we created a prototype
designed to engage public interaction with a single
camera. We installed a camera outside our lab, facing
into a public courtyard (Figure 2), and designed a
movement-enabled game that passers-by could play
with one another, which we titled Brooklyn Blooms.

Movement is detected using software created by
researchers at Bell Labs, who have been developing
techniques to detect and analyze motion from public
camera video [9]. The traditional discrete tracking
approach to motion analysis includes segmentation of
motion features to obtain moving objects, which are
tracked to produce results needed for event discovery
and trend and anomaly detection. The Bell Labs
software uses a motion flow approach that skips the segmentation stage, and instead performs filtering on motion features such as direction, velocity, color, etc. This means the software is excellent at detecting regions of movement, but not designed to parse individuals, which had implications for what kinds of interactions we were able to design into the experience. The software is able to anonymize the video stream—to subtract out moving areas and replace them with movement trace elements (Figure 3), which was also useful in designing the end experience.

The game is played using a display wall (Figure 4) that can be seen in the courtyard outside our lab. The game display is run from an iPad (Figure 5). Passers-by see an image of the plaza behind them on a large display. Instead of seeing themselves, they see flowers ‘blooming’ on the plaza where they are moving (Figure 4). They also see two smaller windows in the large display, one of which shows what the camera sees, and the other of which displays the motion that is being detected by the system. If they move quite a bit and vigorously, they start to create ‘spirit fire’ and additional, larger flowers on the main display window, because the software detects a larger region of motion. If several people move quite vigorously to create an even larger region of motion, then it is possible to create a ‘spirit tree’ in the center of the screen (Figure 6 and 7). This is the final, ‘win’ state of the experience. Creating the tree by working together can happen quite quickly, resulting in a short interaction cycle.

The game was installed during the 2012 World Science Festival, at the Innovation Arcade, which was located in the public plaza directly in front of our lab. Several hundred people, most of them parents and children, wandered past the exhibition. Of those that did pass by, 18% were attracted by the display, and 5% stopped and interacted. The average interaction time was 1-2 minutes, with a maximum time of 10 minutes. Interaction was primarily individual-based, and when it was group-based, did not involve interaction among members of previously separate groups.

Lessons Learned
Brooklyn Blooms succeeded in creating some interest in passers-by in the public plaza, through the use of a large display with active feedback based on movement. Though it encouraged group movement and collaboration to create a final end state, it did not generate a strong coordinated response among those who interacted with it. As has been observed elsewhere with movement-based installations using public displays [1, 8], pre-existing groups tended to engage with it as groups, or individuals engaged with it alone. We did not see active impromptu coordination among strangers. In short, we succeeded in creating a novel camera-based public experience that could engage some passers-by, but we did not observe any mingling of groups, nor did we feel we dove very deeply into the exploration of repurposing public cameras themselves, as we only used one camera which we had installed ourselves.

Phase Two: Liberty Science Center Project
After showing Brooklyn Blooms at the World Science Festival, we were approached by a local science museum, the Liberty Science Center (LSC) in Jersey City, New Jersey, with the opportunity to exhibit our game at their facilities. Based on lessons learned from deploying Brooklyn Blooms, we set out to design an experience that would more deeply engage visitors in
social interaction both within and across groups, and to take a more active stance toward the cameras.

Our goal is to activate the museum’s visitors, who are predominantly children and parents/teachers, to engage with the cameras throughout the museum in a playful and active way. We want to foster collaboration and a sense of community among players. We hope that our game will shift visitors’ sense of the potential that surveillance cameras could hold for serving the public and supporting community in everyday life.

To this end, we are designing a modified play experience with a more extensive technical infrastructure. In addition to a large projection wall, we will have 6-8 surveillance cameras with accompanying displays, and two interactive kiosks. We will be displaying our game in a large exhibit space in the museum, typically the first room that visitors encounter during their visit to the LSC. In this room, we will install a surveillance camera with a large display projected on the wall beneath it. To the side of this display we will install a kiosk (Figures 8 and 9). This is where the main game is played. The remaining cameras and monitors will be installed in pairs throughout the museum.

In the revised game, players’ collective movements reveal a hidden image, much like a hand wiping fog off a window. The display shows players’ progress at revealing the image, along with a timer indicating how long it takes to fully uncover it. A leaderboard will show snapshots of high scoring ‘teams’ (fastest uncovering of image, with a snapshot of the crowd at the moment of completion). The image unearthed in the game is a live stream from one of the cameras installed elsewhere in the museum, encouraging players to explore the museum to find these cameras.

Once an image is completely uncovered, players will get a chance to pose for their ‘win’ snapshot. This will serve as a team’s icon on the leaderboard, in addition to being available on a photo stream that can be accessed through the museum’s website. The kiosk near the display will contain an interface that includes the leaderboard, photo stream from the game, survey (described in the following section), and game statistics (e.g. how many rounds were played, the length of rounds, etc.). Visitors will also be challenged to participate in a camera hunt to locate the other surveillance cameras installed throughout the museum. The monitors associated with these cameras will stream gameplay from the entrance area, possibly allowing for engagement across cameras to occur (e.g. people waving to one another from each end of the surveillance cameras’ streams), thus transforming the cameras into communication channels rather than unilateral monitors. A second kiosk will test players’ ability to identify the locations of the other surveillance cameras, and will reward them with the ability to control which camera view pops up in the next round on the main game screen.

Analysis Strategy
Techniques for analyzing interaction with public displays are still evolving [1, 5, 6, 10]. Our plan is to use multiple methods to gather data from the installation. We will keep a video record of interaction at the main screen, which we can examine later and code for key behaviors. Additionally, we are designing metrics into the game, such as speed of round completion and number of rounds per day. We will also...
be able to use the motion flow software that drives the interaction to get a cumulative picture of movement. We anticipate using these quantitative measures to identify interesting moments in gameplay that we can then code in a qualitative fashion using the video record. We hope to see evidence of between-group play at the main screen, and to use this installation to better understand how to engage people in public camera-based play in general. As we are curious to see how the exhibition affects attitudes about the role that public cameras could play in everyday life, visitors will also be surveyed about their perspectives towards surveillance cameras both before and after gameplay.

The game will be up and running in April, so we should have preliminary insights from the live exhibition, as well as information from the design and development process, to share at the workshop.

Acknowledgements
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References

Figure 9. Top: Aerial view of main exhibit space. Bottom: First-person perspective of display and game space.
Design and evaluation of a multi-user educational touch screen in the Zoo

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Abstract
In this position paper, the design and evaluation of an educational multi-user multi-touch screen system is discussed. The system allowed visitors of the Antwerp Zoo to learn more about the great apes. The design intended to stimulate collaborative use of the system. The evaluation focused on how visitors used the screen simultaneously and how collaboration took place.

Author Keywords
Multi-touch; multi-user; touch screen; collaborative; educational; user experience; UX; design; evaluation

ACM Classification Keywords
H.5.2. User Interfaces

General Terms
Design, Human Factors

Introduction
Traditionally, computer systems feature a single keyboard and mouse allowing only one person at a time to use the system. In recent years, these peripherals have often been replaced by touch screens, especially in more informal settings. The introduction of multi-touch capabilities has made it possible for multiple users to interact with one computer system simultaneously, further facilitated by ever increasing screen sizes. These multi-user multi-touch systems open a range of possibilities for collaborative use of computer systems. It makes these screens particularly suited for use in places that people typically visit in groups with family and friends, such as museums or zoos.
In this position paper, the design and evaluation of an educational multi-touch wall that was installed in the ape house of the Antwerp Zoo (Belgium) will be discussed. The wall was intended to allow Zoo visitors to learn more about the great apes. In the design an emphasis was placed on stimulating visitor collaboration, as it followed the rationale that discussion of educational material with others can facilitate learning [3].

**Touchscreen design**

In order to stimulate the Zoo visitors to collaborate when using the touch screen wall, special care was taken in the design to ensure that collaborative use was more beneficial than multiple visitors using the screen separately. When it comes to collaborative use of multi-user multi-touch systems, it has been observed in that instead of truly collaborating, users sometimes work in parallel on separate tasks, at times even leading to conflicts where users get in each other’s way. This was observed in several studies, e.g. a study concerning the design and evaluation of a multi-touch tabletop application for adolescents to collaborate on school-related work [1], and in a public multi-touch wall setting [2]. These observations made actively stimulating collaboration and avoiding user conflicts one of the main design goals.

The main part of the final design was formed by a multiple-choice quiz. The quiz consisted of three questions that were randomly chosen out of a larger set of questions. Each question had three answer options. Users could select one (or more) answer(s) by dragging banana’s that lay at the bottom of the screen onto the answer(s) of their choice, within the available time (see figure 1 below). More banana’s on the correct answer meant more points. Points were deducted for banana’s that were dragged onto the wrong answer option. This meant that strategically dividing the banana’s over multiple answers was also possible. There were more banana’s than one person could drag in the available time to answer a question, so collaboration was crucial to drag all the banana’s and get a high score.

This collaboration also meant that a decision had to be made about which answers the bananas had to be dragged to. Thus, the users had to discuss the answer options. This discussion among users was important as prior research has shown that discussion might lead to better understanding, and more correct answers when answering multiple-choice questions, even when no one in the group originally knows the correct answer [3].

After a quiz had finished, participants were presented with the option to take a picture of themselves. This
picture was subsequently shown in the high score list that showed the scores from the current day. This high score list could be consulted on the screen when no one was playing the quiz. This high score list with pictures was introduced to stimulate visitors to aim for a high score and thereby further emphasized the importance of collaboration.

Visitors were observed during their interaction with the multi-touch screen. They were unobtrusively watched and listened to from a distance. Semi-structured interviews were held with a number of the observed visitors to discuss their experiences after using the screen.

The quiz was specifically designed in a way that collaborating allowed users to achieve a higher score on the quiz than when the quiz was played alone. In the evaluation we focused on the different ways in which visitors played the quiz together with others and how collaboration took place.

Results and discussion
Visitor behavior and engagement with the touch wall at the Zoo was observed over a period of two months, mostly during the summer holiday. As two or more visitors were often engaged with the screen at the same time, conversations among the visitors provided useful information on their perception of the touch wall. For additional information on motivations etc., a subset of visitors was asked to take part in very short, semi-structured interviews. The following paragraphs describe some of the findings emerging from the study.

Collaboration
The scoring mechanism was devised in such a way that collaboration was stimulated. When visitors were interviewed after playing the quiz, the majority indicated to have understood how this mechanism worked. Nevertheless, it was often observed that, while visitors did discuss the answer options to a question, this did not necessarily mean that multiple people were interacting with the screen simultaneously. Often a group of people discussed the answer options together...
and chose an answer, but subsequently only one person dragged the bananas onto the correct answer while the others watched. In this scenario there was often one person that clearly took the initiative to interact with the system, and drag the bananas.

While the touch screen was not designed with this behavior in mind, the purpose of letting visitors discuss the questions together, thereby facilitating learning, was still achieved this way. The reasons why some visitors used the touch screen in this way were not addressed in the interviews, however, it is clear that not everyone is interested in achieving a high score. It is perfectly possible to answer a question by dragging only one banana onto an answer.

Children, especially younger ones, tended to behave very differently. In general, children were very keen on dragging the bananas and often played a quiz simultaneous with other children. The children usually answered the questions separately, without collaborating. The answer options were not discussed in group and no shared answering strategy was chosen.

Social acceptance
One reason why some visitors did not drag bananas could be that they might have been somewhat embarrassed. The screen was located in a setting where many other Zoo visitors pass by. The interviews showed that some adults perceived the screen to be targeted at kids rather than adults. This view was confirmed by the observation of a number of adults that started a quiz but lost interest when they found out they had to drag the bananas. In addition to the perception of dragging bananas as something for children, the contrasting graphical design of the bananas and the rest of the system might have also played a role. The general graphical design of the touch screen system adhered to the understated corporate identity of the Zoo. This was in contrast with the bright yellow, more cartoonlike bananas.

Collaboration partners
A distinction in behavior between adults and children was also observed concerning the initial approach of the screen and the relationship with the others they played the quiz with. Adults often used the screen together with persons they already knew; family or friends they had come to visit the Zoo with. Children, on the other hand, often joined strangers, especially when these strangers were also children. However, as described above, when multiple children played the quiz at the same time, they were much more inclined to play separately instead of collaboratively.

Approach of the screen
This differences between adults and children were also reflected in the way these two groups approached the screen. Children often walked right up to the screen and joined others already playing a quiz. Adults first looked at the screen from a distance, watched how others were using the screen, and started playing the quiz themselves only when the previous users were finished. While waiting, they often played along, much like watching a quiz on television, discussing the questions and answering the questions for themselves. Thus, even without interacting with the screen, they were still actively engaged with the educational content the screen provided. These Zoo visitors ‘queuing up’ in the area around the screen also confirm the variation in social activities around a public screen observed by Brignull and Rogers [4].
As quizzes only consisted of three questions, visitors waiting for their turn to play the quiz never had to wait for very long. As a result, the necessity to play together diminished. This might have contributed to adults waiting for their turn instead of playing together with strangers. The duration of the quiz was kept short on purpose, to prevent visitors monopolizing the screen, and to prevent leading attention of the visitors too much away from the animals themselves [5].

While the contrasts in behavior between adults and children are described above, of course, a large part of the visitors are parents that visit the Zoo together with their children. In case of these parent-child pairs, it was often the children that took the initiative, dragging their parents to the screen and asking them to play the quiz with them. The parents, on the other hand, held the children back from joining strangers and let them wait until the previous users finished the quiz. Then, parents often read the question to their children and together the bananas were dragged onto the answers.

Conclusion
The evaluation of the touch screen in the Antwerp Zoo showed that adults and children differed in the extent to which the system was used together with others and how much collaboration took place. When adults were concerned, the system was successful in stimulating discussion of the questions, even when only one person was dragging the bananas, or when they were only watching others play the quiz. Children only discussed the questions when playing the quiz with their parents or other adults they had come to the Zoo with. These results show that the design of a public educational touch screen that stimulates discussion and collaboration is not a straightforward process and that it is an interesting topic for further research.

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References


Digital Inclusion and Public Interactivity: How Do Mobile Phones Affect Intergenerational Awareness and Connection in Public Spaces?

**Abstract**

This research paper considers aspects of digital inclusion in relation to public interactivity by looking at ‘baseline’ interactions in public space. Using preliminary observations the effect of mobile phones on everyday experiences of public interactivity is considered. In particular attention is drawn to intergenerational differences when designing interactivity for public spaces. Using preliminary participant observations the techno-social behaviour of each generation are differentiated in terms of social norms around public mobile phone use. Implications are drawn in relation to the design of interactive public spaces, highlighting the need for an approach that includes diverse generations.

**Author Keywords**

Intergenerational contact; mobile phones; public interactivity; digital inclusion

**Introduction**

When attempting to augment public interactivity through design it is important to have an understanding of the underlying dynamics that go towards determining the nature of public spaces. Here we...
consider the ubiquity of mobile phones in defining the social and technological affordances of such spaces and the ways that different age groups engage with these opportunities. The pervasiveness of the mobile phone is hard to ignore with an estimated 70% of the world’s population now owning one [8]. From its inception it has had a profound effect on social conduct in public spaces with many viewing its appearance as an annoying intrusion [7]. The acceptability of mobile phone conversations in the midst of ongoing communal activities still remains a contested social norm [4] and something which seems to exist across cultures [2]. They have become ever present motifs of modern public life competing for the common grounds of intersubjective awareness and disrupting the social norms that previously existed in public spaces. Understanding how these technologies define the nature of public space is important if we are to augment this space with further interactive technology. Community displays which are often hailed as the most imminent form of future public interactivity will often enlist mobile phones as conduits for their interactivity [1]. In this context disparities of access between generations are beginning to be recognised [6] but more needs be understood. In this paper we consider these disparities in more detail by looking at generational differences in terms of the social practices that surround public mobile phone use and explore the possible repercussions that these may have for the design of public interactivity.

A number of factors will affect the adoption of new techno-social practices. These include previous experiences with similar technologies, the expectations and demands of social context and pertinent socio-demographic variables such as age, education and socioeconomic status [10]. Younger people will tend to be early adopters of new technologies and accompanying social practices [10] and this has certainly been the case with the mobile phone. In the UK for instance 91% of 12 to 15 year olds now own one and 98% of 16 to 24 year olds [9]. In contrast only 80% of those over 65 have a mobile and only 51% of those over 75 years of age [9]. Still these figures only provide a picture of intergenerational differences in terms of ownership of the physical device. It is only when we consider the everyday attitudes and social practices that accompany mobile phone use that generational differences start to become apparent. 79% of the 16-24 age group consider their mobile phone to be their main point of contact with others [9]. Studies across Europe have shown that teenagers and young adults are highly dependent on their mobile phones and emotionally attached to them, keeping them at hand constantly and frequently using them in public spaces [11]. In contrast only 12% of those aged 65-74 consider the mobile phone as their main route to social contact and only 5% of those over 75 [9]. Studies exploring older people’s attitudes towards mobile phones suggest that they see them as very different kinds of devices. They are principally employed to ensure safety and security on specific journeys outside of the home and as such are generally not used for extended conversations or even turned on when not in use [5]. One would suspect that these quite distinct interpretations of purpose would be mirrored in differing social norms between the youngest and oldest generations and their corresponding use in public space. So far there is little research to verify whether these differences exist, whether they are age related and if so how they are reconciled (or not) between generations in public spaces.
Methodology
In order to understand the intergenerational dynamics of mobile phone use as a background element to public space a pilot observational study was embarked upon with a view to documenting each generation’s technosocial practices in relation to public mobile phone use. Investigations employed participant observations in public spaces in the city of Brighton in the South of England. Broad generational patterns of mobile phone behaviour were identified in terms of accompanying body language, use of personal space and other effects relating to face to face interaction. Distinct generations were identified in line with Erikson’s life stages [3] with the following broad categories: children (under 13); adolescence (13-18); young adulthood (18-35); adulthood (35-65) and old age (65+). Observations were carried out in four different public locations1 for a total of 21 hours from 10am and 3pm between 19th June 2012 and 10th July 2012 involving approximately 120-150 people. No children were observed using mobile phones during this study.

Generational Behaviours
ACROSS THE AGES: DEGREES OF MULTITASKING
A clear difference was observed in terms of each generation’s ability to interweave their use of mobile phones with other on-going (and off-device) activities. In locations where adolescents and young adults were walking (or cycling) through the city they would continue to do so whilst texting or talking on their mobile phones, showing a high degree of divided attention and a propensity to multitask. In contrast old aged users in these same locations were more likely to stop everything else they were doing in order to talk or text. Adults (those between 35 and 65) showed varying degrees of multitasking ability when using their phones often walking slower or sitting down when using their phones.

ADOLESCENTS (13-18): THE SEAMLESS SOCIAL NETWORK
Gatherings of teenagers in public places were often accompanied by simultaneous use of mobile phones, iPods and/or portable gaming consoles. This was observed with college students (aged 15-17) travelling on the train (in location 3) and in the centre of the city (in location 4). In these gatherings they would sit or stand in a circle with each individual seemingly focussing their attention on their individual screens. Whilst this might appear to be an isolating activity in terms of removing direct eye contact from one another in other ways the sense of a social meeting was maintained. Whilst their visual attention may have been occupied their auditory attention remained available to one another with conversations continuing despite ongoing and simultaneous texting or updating of social networks. At times they would share their online activities with one another creating conversations that incorporated (absent) others via their recent text and photo postings to social networking sites. This resulted in what might be called a ‘seamless social network’ in which online social activities were integrated into immediate person to person (rather than face to face) gatherings and vice versa.

1 Four different locations were used as the basis for initial observations: 1) a paved walkway and sitting area adjacent to a well frequented local landmark (the Royal Pavilion) 2) a bus travelling through the centre of the city 3) a train travelling into the centre of the city and 4) a communal space and sitting area outside the public library in the centre of the city.
YOUNG ADULTS (18-35): PHONE AS COMPANION AND THE PUBLIC/PRIVATE BUBBLE

Groups of young adults in public did not engage in the seamless social networks of their younger counterparts but tended to exclude those present from their conversations by removing eye contact and orienting their bodies away from any congregation whilst talking on their mobile phones. Mobile phone conversations were not curtailed because of this exclusivity but were accepted by the rest of the group without complaint creating a public/private bubble. For those receiving calls there was variation in the prioritisation of mobile phone voice calls over immediate face to face interactions. Different levels of discretion were used and this would dictate how much they lowered their voice, avoided eye contact and/or withdrew from the centre of the congregation whilst talking on their phone. Text messaging was less common amongst this group when they were out with others in a public space. Young adults were the most visible users of mobile phones in public places. A distinctive aspect of their presence in these places was that they were often seen alone. In these instances the mobile phone was carried in hand and displayed as a symbol of social status implying continual social availability and connection, i.e. they were not really 'alone'. In such a way the mobile phone appeared to act as a constant companion for many solitary young adults.

ADULTS (35-65): EFFICIENCY IN BETWEEN MOMENTS

Mature adults were observed using their mobile phones at moments in-between activities or places. Mobile phone activity (whether texting or talking) occurred at particular thresholds just prior to entering buildings such as upon leaving the library or entering a convenience store (both in location 4). This group were more likely than other age groups to be seen talking on their phone when alone. Phone use occurred during times that would have otherwise been taken up with ‘mindless’ activity such as walking and which made efficient use of available thinking time.

OLD AGED (65 +): DISCRETE USE

For the most part older people’s use of mobile phones was either non-existent or hidden from public view. Out of all the older people observed only three of them were seen using their mobile phones in public. On each of these occasions their use of the technology was what one would call ‘discrete’. They would stop whatever else they were doing, take their phone out of a bag or pocket, use it for a distinct purpose and then return it. This appeared to be driven by a need to attend to a single task at a time but was compounded by difficulty in seeing the mobile phone when moving. Some older adults would put on glasses or adjust them in order to read and operate the phone. Those phone conversations that were observed were short and to the point.

INTERGENERATIONAL INTERACTION

Throughout the observations social contact between strangers of different generations was seen very rarely. This was certainly true in terms of conversation but also in terms of the nonverbal precursors that one would normally expect to precede conversation. On the whole different generations appeared very tolerant of one another’s mobile phone behaviour but common ground for conversation did not emerge often. The only time this was seen to happen was with a baby and an older person on the bus with the mother operating as intermediary and ‘translator’.
Implications for the Design of Public Interactivity
These preliminary observations suggest important differences between generations in terms of their public use of mobile phones and correspondingly their definitions of what constitutes ‘public’ space. Understanding these differences is important if we are to engage all members of a given community equally through interactive spaces. Those spaces which harness the ubiquity of mobile phones for public interactivity will have to accommodate these different uses and expectations in relation to mobile phone use if they are to be truly inclusive spaces. Similarly interactive spaces and displays which make use of more direct interactions such as gesture and touch will have to compete with these background dynamics if they are to engage public attention at all. An underlying assumption for both approaches is that public interactivity can be encouraged by providing a common ground for social interaction or social ‘triangulation’ opportunities [6] at the interface. Whilst it would be possible to tailor public interactivity to a particular generation the significance of an intergenerational context in defining triangulation possibilities should be acknowledged as significant during design. This study of intergenerational ‘baseline’ interactions is ongoing and whilst some basic categories of generational behaviour have been described here more research needs to be done to ascertain how these differences are reconciled in public space.

References
Towards Understanding the Cognitive Effects of Interactivity

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Abstract
Cheap and easy-to-deploy consumer hardware, such as the Microsoft Kinect, touch screens, and smartphones drive an increasing proliferation of public space with interactive applications. Such applications include artistic, playful, and informative content on public displays. Though such applications are in general positively perceived by users, their benefit is in many cases not clear. In this paper we argue that while most current (advertising) content on public displays aims at stimulating user action (e.g., making a purchase), interactive applications are also suitable to support cognition. In our work, we focus on awareness as one particular form of cognition and assess it by measuring recall and recognition. This is not only interesting for advertising but for any type of applications that requires the user to remember information. We contribute a design space and map out directions for future research.

Introduction
Public displays have become an essential part of the urban landscape. They are widely deployed by large outdoor advertisers as well as increasingly by smaller retailers, restaurants, bars, and public institutions. The main use cases for setting up public displays are advertisement (e.g., in airports, railway stations, and high streets), signage solutions (e.g., in public buildings), and attractiveness of locations (e.g., screens in bars and cafes).
Undoubtedly, there is nowadays a tiredness among passersby of public displays that show pure, static advertising content. This led to what has previously been termed the display blindness [12]. Providers of public displays have recognized this problem and increasingly try to create more suitable content consisting of small chunks of information that are displayed in a time-multiplexed way. For example, displays in subway stations show news content, followed by the weather forecast, and short cartoons. Occasionally there is interlacing with (contextual) advertisements. Though this makes public displays more attractive to passersby, it still does not exploit the full capabilities of interactive displays that actively engage the user [1]. Devices such as the Kinect or touch-enabled displays allow interactive applications to be deployed (see Figure 1). In previous research, it is shown that interactivity has the potential to increase the user experience [8]. Examples exists today, where display owners are experimenting with such applications, but the majority of outdoor display owners are still reluctant to deploy interactive displays.

In this paper we present an early design space for interaction with public displays. We outline the necessary dimensions and discuss their possible values.

Background and Related Work
In this work we are interested in how the effectiveness of public displays for communicating information and creating awareness can be increased. Prior work on interactive television [9] and on web pages [14] indicates that interactivity of content may have a positive impact on cognition. However, these results are specific for these media types and cannot easily be applied to public displays. Nevertheless they inspired us to investigate the impact of interactivity on recall and recognition on public displays.

Researchers have investigated different aspects that influence cognition, including personalization and participation [5], comprehension [17, 18], and feedback [7]. Bezjian-Avery et al. investigated the effect of the presentation and nature of the message as well as the user’s personality characteristics [4]. From these publications it can be deducted that interactivity engages the users and hence has a potentially positive effect on cognition.

Further research looked into this effect. Risden et al. showed that interactive Web games are more likely to increase brand awareness compared to a TV ad [15]. Cho et al. [6] found that interactivity has a positive impact on attitudes whereas no influence on user satisfaction can be attributed [16]. Bezjian-Avery et al. [4] showed, that interactive ads in many cases do not outperform traditional ads. These findings partially contradict our expectations and motivated us to investigate this in more detail.

In order to understand cognitive effects (particularly awareness) it is important to know how to measure them. We draw upon the S-O-R paradigm [3], which today forms the basis of many models [10]. In contrast to the classic Stimulus-Response paradigm that considers cognitive processes as a ‘Black Box’, the neo-behavioral S-O-R paradigm considers hypothetic constructs, including involvement, emotions, motives, attitude, values, and lifestyle as intervening variables that affect cognition.

Design Space
This paper focuses on interactive public display applications, that enable playful interaction with objects on the screen. We expect such applications to be suitable for displays deployed in public spaces. We believe that interactivity makes public display applications more interesting and creates a benefit for both, display providers and users.
<table>
<thead>
<tr>
<th>Dimension</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weak occupation</td>
<td>In these situations, people are open to perceive the content of displays, are relaxed, and are more likely to be taken in. Examples include waiting situations occurring at bus / train stations, next to the coffee maker, or the copy machine.</td>
</tr>
<tr>
<td>Strong occupation</td>
<td>In many situations where people encounter public displays, they are in a hurry and are on a schedule. Generally, this leads to shorter interaction times and content usually needs to be specifically designed for such situations.</td>
</tr>
<tr>
<td>Non-interactive Content Only</td>
<td>Non-interactive content does not enable interaction but constitutes a static, constantly visible part of the application.</td>
</tr>
<tr>
<td>Mixed Content</td>
<td>Particularly for complex scenes, applications may consist of varying degrees of interactive and non-interactive objects.</td>
</tr>
<tr>
<td>Interactive Content Only</td>
<td>In applications with only interactive content, users can interact with any object shown in the application.</td>
</tr>
<tr>
<td>Direct Interaction</td>
<td>Direct interaction describes techniques where users directly control the object they are interacting with (e.g., touchscreen).</td>
</tr>
<tr>
<td>Indirect Interaction</td>
<td>Indirect interaction refers to techniques that involve sensors and processing to translate the user’s motion into a representation on the screen (e.g., Kinect, mobile phone).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrating the Message</td>
<td>In the simplest case, users are only interacting with the message, e.g., the latest Nike basketball.</td>
</tr>
<tr>
<td>Message &amp; Content (Separated)</td>
<td>A scene can contain further content apart from the message, e.g., static background and Nike basketball.</td>
</tr>
<tr>
<td>Message &amp; Content (Integrated)</td>
<td>Message and content can be interweaved making the distinction not obvious to the user, e.g., a brand logo on the interactive object.</td>
</tr>
<tr>
<td>Low Expressiveness</td>
<td>People only interact with their hands and do not make any expressive movements (e.g., touch).</td>
</tr>
<tr>
<td>High Expressiveness</td>
<td>People make whole body gestures and move in front of the displays as they interact (e.g., gestures).</td>
</tr>
<tr>
<td>Prior Knowledge</td>
<td>The message shown on the display is not new to the user (e.g., an ad they have seen before).</td>
</tr>
<tr>
<td>No Prior Knowledge</td>
<td>The user does not know the message (brand or product) a priori.</td>
</tr>
</tbody>
</table>

**Table 1**: Design space for interactive public display apps.

To understand the design space for interactive public display applications, three researchers and one student reviewed prior work on interactive public display applications (papers, videos, project websites). Based on the material, a set of dimensions was extracted that potentially affects recall and recognition. We discuss each of the dimensions and identify relevant values (Table 1). Note, that the values for each dimensions are in most cases not discrete but should rather be considered as a continuum.
User Situation
Public displays are deployed in various locations. This leads to people encountering them in very different situations, e.g., while waiting, while passing by, while eating, or during shopping. In weak occupation situations, people usually have more time to engage as compared to strong occupation situations such as while en route to work.

We discussed whether it would be sufficient to simply consider the time users are interacting with the display. However, we feel that further aspects, such as stress or current cognitive load, may have an influence. Hence, we suggest a continuum between weak and strong occupation situations.

Interactivity of Content
We found that scenes on public display often contain many different objects, of which some are interactive and others are static and non-interactive. We expect a difference in recall and recognition, depending on whether an object can be manipulated or not. Hence, the following cases are distinguished: (1) the screen contains only non-interactive content (this is the case for all current, non-interactive public displays), (2) the screen contains (to varying degrees) interactive and non-interactive content (e.g., interactive foreground, static background), or (3) all objects on the screen are interactive.

Interaction Type
The technology deployed usually determines the type of interaction. Whereas touch-enabled screens enable direct interaction (i.e., dragging/dropping an object), gesture-based techniques are indirect and require a mapping of the user interaction to the feedback on the screen. Thus, the expressiveness of the interaction can be controlled, e.g., by implementing a transfer function that requires the user to move more or less in front of the screen.

Integrating Content and Message
According to Alt et al. [1] we identify three ways a message can be placed within an application. Messages could be shown exclusively (i.e., with no other content on the screen), with other content on the same screen but separated, or they could be integrated with other content.

We believe that additional content could indeed influence memorability. Prior work shows that people remember content around interesting magazine articles less than content around less interesting articles [13].

Expressiveness of Interaction
Nowadays, various interaction techniques exist that have a potential influence on recall and recognition. Such techniques include touch, gestures, presence, etc. A comprehensive overview can be found in Müller et al. [11]. These different interaction techniques require different levels of expressiveness – for example, applications that use the presence of the passerby require less expressive movements than a game that uses whole body movements. Hence, we distinguish low and high expressiveness.

Prior Knowledge of the Message
We believe that the user’s knowledge about a message could have a strong influence on recall and recognition. For example, if a user knows the brand advertised, this might positively affect whether or not they can remember the message on the display. An application that can identify the user in front of the display could exploit this and adapt the presentation. Hence, we distinguish between prior knowledge and no prior knowledge of the message.

Discussion and Conclusion
In this paper, we propose a design space and describe important dimensions that need to be taken into account when developing interactive public display applications.
that aim at having a cognitive effect on the user. We see the design space as a basis for future research that looks at cognitive effects of interactivity in more detail. As an ultimate goal of our research we envision concrete guidelines for (1) display providers in order to understand how to ideally place public displays, and (2) for content designers, in order to understand how to best integrate the message they want passersby to remember.

References
The Perceptual Cloud

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Abstract
In this position paper we argue that the decoupling of the computational and the interaction substrates leads to a new paradigm of human-computer interaction in public spaces, which, insofar, has only been part of Science Fiction and new media artworks. This new paradigm will have a tremendous impact not only on what users assume and expect from computational interactive systems, but also on everyday life and its concerns, especially privacy, image ownership, perceptual ownership.

Author Keywords
decoupling, cloud, ubiquitous computing, new media art

ACM Classification Keywords
H.5.0. Information interfaces and presentation (e.g., HCI): General.

Screens, screens everywhere
Screens have become an integral part of the human experience. With at least a 75% of the world population with access to a cell phone [10], people naturally introduce screens in every aspect of their everyday life. With the addition of cameras and touch surfaces to almost every screen-based device, screens are now bi-directional communication devices. They are not only devices to be looked at, but also devices that look back at us.
This, as often is the case, has been made explicit by new media artists, even to the point that “magic mirrors” have became a gesture, or cliché, or design pattern in new media art (it has been said that mirrors where the first interactive art pieces).

Even more notable is that we are training these devices not only to look back at us, but also to “understand” us in a similar, or coherent, way with how we perceive and understand the world and ourselves. Devices that recognize faces, infer emotions, body postures, and gestures are present in a wide range of devices, from photo cameras to video games and TVs.

The bi-directionality of the screen is ubiquitous, and the difference between sensing and showing information is blurring, not only by the extremely frequent camera-screen pairing but also with the introduction of sensing pixels, Wedge-like devices [8], and touchscreens.

Privacy, surveillance, and big brother concerns are common themes in the media arts, as art many times takes as its duty to reflect on new concerns.

As Christian Paul states: “technologies often tend to develop faster than the rhetoric evaluating them, and we are still in the process of developing description for arts using digital technology as a medium—in social, economic, aesthetic respects.” [5]

Decoupling
A parallel trend –which can be somewhat seen as a wink to the mainframe paradigm of earlier computing days– has been recently dubbed “cloud computing”, where different operators can provide almost everything “as a service”. Definitions of what is currently offered as a service overlap and comprise, among others, infrastructure as a service, platform as a service, storage as a service, software as a service, data and databases as services, and testing as a service.

The “cloud” should not be understood only as the remote use of computing power, data storage or another infrastructure, but also as the effective decoupling of the computing power (in its broader sense) from its human interface.

Although remote storage and remote computing have been present for a long time in computer history, its seamless, transparent, or invisible integration into mobile devices is very new. Apple’s Siri service for their iPhone smartphone remains one of the most used and relevant examples. Siri (which stands for “Speech Interpretation and Recognition Interface”) offers a versatile natural language interface capable of understanding many basic phrases and to reply in a spoken voice. What it is remarkable is that this interaction is performed by a mobile device that uses Apple’s servers to process the audio (and store it, which should rise a great concern for the users’ privacy1).

This decoupling of the processing and the interface is invisible to the user (unless the user has limited or no connectivity, in which case the service does not run). The phone acts as an interface for a remote computing

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1 IBM forbid its employees to use the feature, as reported in http://www.technologyreview.com/news/427790/ibm-faces-the-perils-of-bring-your-own-device/
service but, for the user, it is the device that performs the operation.

A second decoupling of the computing and interaction layers has received many names and has seen many incarnations. At University of Tokyo, Cassinelli’s team coined the phrase “invoked computing” for one instance of such decoupling [11]. They propose to empower the users with the ability of invoke computing behaviour onto any physical device (they showcase this with a pizza box acting as a laptop computer and a banana acting as a telephone). This is accomplished by using image projectors converting any reflecting surface into a screen, and parameter speakers using ultrasound to “project” sound into any object.

Other examples of this with steerable projectors that can point to arbitrary spaces can be found in our own Mapinect [4], and in Microsoft Research’s Beamatron [9].

As Cassinelli’s points, when introducing Invoked Computing, “the most challenging part of this proposal is the automatic detection of suggested affordances.” Although this can be side-stepped by users learning a set of command gestures, or by presenting users with, for example, projected touchable menus, the “magical” augmented reality-like properties that Cassinelli et al.’s propose do require the automatic correct interpretation of the invoker object’s affordances.

The perceptual cloud
Even if both mentioned decoupling strategies are not entirely new, their combination is not only novel, but also it will have a profound impact on everyday life and on how we conceptualize computers and their use. The future scenario is this: every surface within every object everywhere is a potential interaction device or part of an interaction device. Every surface is a screen, every object a speaker. Every suggested, metaphorical, affordance of every object is real. Every user movement, every gesture, every spoken word is analysed, is reacted-to, and possibly recorded.

Even if we do not know the exact implementation of this radical transformation of the environment, we are confident in its unavoidable advent. The required ubiquitous sensing and audiovisual projection will probable be achieved by a combination of in-situ devices (projectors, parametrical speakers, etc.) and wearable appliances (in the styles of MIT’s 6th-sense [3] or Google’s Project Glass [6]).

It is the double decoupling of the perceived interface support from the actual interactive device, and the perceived computing support from the actual computing device what will allow for this radical transformation of everything everywhere.

In this paper, we name this the Perceptual Cloud.

Art in the Perceptual Cloud
There are many objections to the idea of a perfect choreographed Perceptual Cloud, and the ways that companies will steer towards their most profitable future is yet to be seen, but, regardless the implementation details, a version of it will certainly happen, and it will constitute a fertile field for artistic expression and reflection.

Street and Public Art are not only old ideas, but also conform a legitimized artistic area, with, for example,
Los Angeles’s MOCA having run a major exhibit on Street Art in 2011.

Even if we still do not know what art in the Perceptual Cloud will be, there are a number of common themes that will not only translate onto the Perceptual Cloud, but also their concerns and interests will be amplified by it.

What artists have to say about privacy, visual pollution, and control in the Perceptual Cloud era? It is indeed easy to think of a mash-up of ad-blocking software and Julian Oliver’s *The Artverter* [7], but in a realm where everything can display information, see us, and react to us, this approach appears somewhat naïve.

Quoting Gärdenfors: “As the number of screens around us grows, the way information is designed will need to change. With each individual screen trying to grab our attention, we might respond by learning to ignore them to avoid information overload. To counter this possibility, could we imagine new and complex screen arrangements that act to our advantage by addressing real and immediate needs?” [2]

The same translation applies to privacy and surveillance. How artists will react to our exacerbated Orwellian future?

The opportunities the Perceptual Cloud offers are immense. Besides collaboration and delegation being taken to new levels, a new type of artworks might arise.

The creation of awe has been one of the main aesthetic objectives of new media art, yet, with the normalization of the interactive technologies, the medium of interactive digital arts is reaching a new state of maturity where the immediate reflex of showcasing a new way of capturing users input or to display information will not longer be active.

In the Perceptual Cloud, the ideas of screen, interaction, devices, and affordances will be malleable. (The dish where you eat reminds you of a steering wheel? Well, then it is one). The embodiment opportunity that Natural User Interaction offered media artists has to be re-situated into a reality where everything can embody anything in a way that it is natural and transparent for every user.

Yet, it is the concept of a malleable notion of interaction is what offers the widest opportunities. For interacting with computers (in the most general sense) will not be anymore defined by any pre-conceived set of gestures, interfaces, devices, or reactions.

Although nonspecificity was the "curse and opportunity of computer art" where "everything is possible but nothing is necessary" [1] an artistic language of computer art has been created. This is about to change. In the Perceptual Cloud the pre-conceived ideas of computer representation and interaction are to be expanded and radically changed.

The very human universe will be expanded, and it is for the artists, again, to find the necessary.

References
I Can Hear You – Private, Public, and Social Sonic Interactions in Public Spaces

Abstract
Public spaces are quickly becoming full of systems and appliances that display information not only visually but with audio. Some of these devices we even carry with us and interact with no matter where we are, emitting varying degrees of sound matter to our environment. This position paper addresses and brings forth questions of the emergence of such sonic interactions and implications on their design for public spaces. Special attention is devoted to the social acceptability of such interactions and the sometimes-vague boundary between private and personal.

Author Keywords
Sonic interaction design; social acceptability; privacy

ACM Classification Keywords
H.5.1. Information interfaces and presentation (e.g., HCI): Multimedia Information Systems---Audio input/output.

General Terms
Design, Human Factors.
Introduction
Imagine a trip on an overbooked train, sitting comfortably on your seat, playing games on your mobile device. The device is on silent mode, which is the way you prefer to use it in public spaces, and the sounds of the particular game are not especially interesting anyway. The person sitting next to you is also playing on his mobile phone, but wears noise-canceling headphones to enjoy the game sounds in his virtually private space. The interaction that is clearly audible to the whole car, however, comes from a young couple sitting on the floor of the car, playing an action-packed shooting game on their tablet without headphones, with the device volume turned all the way up. From what you can deduce, they want to share the experience of playing the game with each other, while taking turns playing the game, but at the same time they expose one of their interaction modalities to the dozens of other passengers in the near vicinity. Apart from a few audible sighs and mutters from the people sitting closest to the action, there are no perceivable objections or interventions from the involuntary audience. Are you annoyed by the low-fidelity crashes, booms, and beeps emitted by the lo-fi loudspeaker? Or are you perhaps strangely also half-engaged following the experience of these two excited young gamers?

The scenario brings forth several points related to the utilization of sound in ubiquitous interactive systems that are available in public spaces. The notions also extend beyond personal devices of the example, towards publicly installed interactive systems such as information displays and artistic installations, for example. This paper aims at discussing the social acceptability of sound in this context and the possibilities and challenges related to shared, public, and private sonic interfaces. Indications for the design of future systems are outlined.

Related Work on Social Acceptability
Regarding social acceptability of sonic interactions, there are not many examples in previous literature. Rico and Brewster [5] have discussed the social acceptability of gestures, indicating that the acceptability of gestural interactions is dependent on the audience and location. Home was in general seen as a safer venue for performing gestural interactions than a more public setting. Significant variation between individuals was found in what was considered acceptable.

Although the set of gestures by Rico and Brewster [5] includes handclap as the only clearly audible gesture, in a follow-up study the same authors have also examined the social acceptability of voice commands and conclude that the findings are similar [6]. In addition, the acceptability of gestural interactions has been shown to vary also depending on the public space, e.g., between a street and a bus [8].

Sound as an Interaction Modality
Sound has for decades played a part in computational systems and HCI. Yet, it can be argued that the full potential of sound as an interaction modality has not been harnessed and that graphical interfaces, for example, are far more advanced than auditory interfaces. Using sound as input has been particularly neglected except for the context of speech recognition.

In the recent past, a new field of studies called sonic interaction design (SID) emerged from the combination of interaction design with sound and music computing.
research [2]. Regarding sound as the primary channel for conveying information, meaning, aesthetics and emotion, the studies in the field of SID have brought forth new concepts and methodology in the use of sound as an interaction modality.

This SID effort can be considered as an extension of facilitating non-speech audio as an output modality in computational systems, for instance by means of auditory icons or earcons [1]. The distinction, however, is that SID relies on sounds to couple to and guide continuous interaction, beyond the warnings or auditory display of discrete system events. Various interaction design ideas and case studies on SID have been presented in a recent book on sonic interaction design [2]. Not enough attention has been paid on sound as an input modality, however.

Sound as input can be roughly categorized into speech and non-speech input. Speech interfaces have become somewhat ubiquitous and are often applied as voice command or voice query interfaces, such as Siri by Apple, and the research tracks in the field are numerous.

Using non-speech sounds as input in interactive systems has gained less attention but has been broadly discussed, e.g., by Jylhä [3] and Sporka [7]. It can be argued that there are a wide variety of sonic gestures that are applicable for HCI applications, although practical examples are still limited. In addition to direct interactions with gesture-like sounds, the sonic input may also be indirect. For example, an interactive indoor map system could utilize the overall soundscape in a room to deduce the activity level currently set in the room and display this information to the user.

Social Acceptability of Sonic Interactions in the Wild

Regarding the use of sound for interactions in public spaces, either as input or as output, the concept of social acceptability is of utmost importance. As the example in the introduction highlighted, people may react to sonic interactions in the environment in different ways. These reactions may, however, change over time. Think for example a few years back when mobile handsets were augmented with hands-free devices and suddenly there were loads of people walking on the streets talking apparently to themselves. At first, people who were exposed to these early adopters were likely surprised and maybe made negative judgments of these walking talkers. But now most people especially in more crowded areas are accustomed to the fact that a person walking and talking is most likely engaged in a phone conversation. Thus, this phenomenon became socially accepted. Similar development can be envisioned, within reasonable limitations, also regarding other systems, which involve sound either as input or output.

Private, Public, or Social?

Sound is by nature shared and social. While it is possible to close the eyes or turn away from an unwanted sight, it is much more difficult to close the ears from an unpleasant sound in the environment. Sound is a key channel of human communication and we are well tuned to make meaning out of our surroundings by listening.

In this sense, using sound for private interactions in public spaces may seem challenging. Do we want to expose our private interactions and their content to our surroundings? In many cases, it would be easy to argue...
for better privacy in these settings using other modalities. Yet, all over us people are already talking their personal matters on their mobile phone without significant discretion. This behavior has grown onto us.

Public interactions are another story. Systems that have been designed to be interacted with in public settings, such as information displays that may contain auditory elements, are not as sensitive w.r.t. privacy issues. Navigating an interactive shopping mall map giving speech cues on shop details, for example, is hardly exposing any private information and may even provide some cues also to passers-by.

Due to its nature sound poses numerous options for creating social interactive systems. We can envision, for example, a social sound-based interactive game installation on a central square in the city. The sounds emitted by the system and/or the people interacting with it would not only serve the gamers but might also attract people from the near vicinity to participate.

Indications for the Design of Future Systems

The design space for systems utilizing sound as an interaction modality in public spaces contains several dimensions, many of which are highly dependent on the context. The context itself is an ambivalent concept, but with sonic interactions at least the following should be considered:

- How much background noise there is and is the noise constant or varying? This affects the sound design in many ways. On one hand the relevant sounds need to be distinguishable from other environmental sounds. On the other hand, in general the sounds themselves should not add unnecessary clutter to the soundscape.
- How many other people are around? This is important for potential privacy issues.
- Is the person using the system on the move? This poses constraints for placing the microphone, for example. If a mobile device is in the pocket of the pants, the microphone mainly captures the sounds of the device scraping the fabric.

Regarding sound output with personal devices, the easy solution to keep it private is to use headphones. By contrast, the reliability of using sound specifically as input for personal interactions in public spaces may be affected by other environmental sounds. However, as has been discussed for example by Jylhä [3], in some cases it is possible to tune the system to distinguish between the sounds of its owner from those of others.

Another point in public and social sonic interactions relates to proxemics. Figure 1, inspired by the findings of Peltonen et al. [4], depicts different zones of activity in the context of a visual multi-touch display. The interactivity varies depending on how far from the screen the person is. Would a similar zone distribution apply also for sonic interactions? Could sound as an additional modality transform the zones, making it easier for people on the further zones to participate?

Proxemics also has a role in private interactions due to sound attenuation and masking. Even in public spaces it may be possible to have a private zone, especially if there is significant background noise, because the sound does not reach the other people in the space.
Figure 1. The zones of interaction w.r.t. proxemics in the context of an interactive screen.

Conclusions
Sound as an interaction modality in public spaces poses different constraints but also new possibilities for designing private, public, and social interactions. We pinpointed some aspects of the design of sound-based interactivity for public spaces. However, the social acceptability and contextual application of sonic interactions should be studied more in order to provide concrete guidelines for design.

References
Gesturing at Architecture: Experiences & Issues with New Forms of Interaction

Abstract
When developing public installations, interaction designers are able to utilise increasingly natural modes of expression such as speech, gesture and touch. Conversely the resulting installations often place users in situations where they are confronted with entirely unnatural forms of interaction. How do we establish an understanding of peoples’ behaviour in such situations, and what bearing could this have on the design of better interactive experiences? This paper addresses these questions, drawing upon a study of a high profile installation that invited members of the public to control the lights on the London Eye using hand movements and heart rate measurements.

Author Keywords
Media & art; gestural interfaces; architecture; London Eye; Microsoft Kinect; mood; emotion

ACM Classification Keywords
H.1.2 [User / Machine systems]: Human information processing; H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; I.2.10 [Vision and scene understanding]: Video analysis.

General Terms
Design; Experimentation; Human Factors
Introduction
The last decade has heralded a new era for human-computer interfaces, characterised by technologies that seek to reflect and imitate our evolved interactions with other humans and our physical environment. Where we once used clunky joysticks and keyboards, computers are now able to recognise more natural forms of input such as touch, gesture and speech. What’s more, the hardware associated with these interfaces is becoming increasingly miniaturised and affordable. Consequently such technologies are particularly amenable for applications in public spaces, where they can be deployed in short time frames, and with little impact on existing infrastructures. The versatility afforded by this convenience has led interaction designers to come up with increasingly innovative interactive experiences (for an example see ‘Perspective Lyrique’ by creative collective 1024 Architecture). For those partaking in such experiences the novelty of the interaction is what provides much of the excitement and intrigue. However, for the psychologist, social scientist and interaction designer the obscure nature of these new forms of interaction poses many interesting questions. We believe that one of the best ways to address these questions is to encourage interaction researchers and designers to undertake collaborative studies involving the collection and analysis of real-world data from public installations. During the summer of 2012 we had the opportunity to be involved in such a study when we worked with Cinimod Studio in London to design and analyse a high profile interactive installation called the Mood Conductor.

Background
The Mood Conductor combined both gestural and physiological interfaces in order to allow a person to interact with an architectural landmark. We briefly discuss these modes of interaction below.

Gestural Interfaces
When we talk of gestures in human-computer interaction we are loosely referring to the use of finger, hand or bodily movement as a means of input. Touch screens act as two-dimensional gestural interfaces allowing simple gestures to be performed, such as pinching two fingers together to zoom in on an image. By sensing motion in three-dimensional space more complex and expressive gestures can be performed. In 2010 the release of the Kinect brought motion sensor based interaction into the homes of millions of people around the world, allowing users to interact with computer games using free bodily motion. Since then the development and release of open source drivers has led to it being widely adopted by third party developers in a range of applications including art, advertising, entertainment and healthcare (see the Kinect Hacks website for examples). A problem with the Kinect as a gestural interface is that it lacks the resolution to accurately detect small movements. This issue could be addressed by the LEAP motion sensor, purportedly capable of tracking finger movements to a precision of 0.01 millimetres. Due for release early in 2013, the LEAP sensor is evidence that gestural interfaces are here to stay and will have an important role in the human-computer interfaces of the future.

Figure 1. Photo of a participant on the Mood Conductor

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1 http://www.1024architecture.net/en/projects/
2 http://cinimodstudio.com/
4 http://www.kinecthacks.com/
5 https://leapmotion.com/
Physiological Interfaces
The electrical activity of the brain, heart and muscles, as well as biochemical activity such as perspiration, can all be measured using biosensors, which have become increasingly low-cost and unobtrusive in recent years. Since many aspects of physiology are closely linked to cognitive processes it is possible to relate physiological measurements to felt experiences such as emotion and mood. This has led to the use of physiological signals in domains of interactive art and media such as computer gaming [1], musical performance [3], and film [2].

Architecture as a Medium for Interaction
The use of architecture as a component in digital art is a concept that has been popularised in recent years by the practice of projection mapping. Projection mapping involves manipulating 2D projections such that they appear to be superimposed on the surfaces of 3D shapes. When coupled with well-designed content the effect can be incredible, transforming static buildings and objects into surreal, colourful and animated forms. There are, however, only a few examples of projection mapping projects that feature an element of live human control or interaction (see works by the companies Seeper and YesYesNo).

Fixed lights, soundscapes and movement also present opportunities for people to control or interact with physical structures. As concrete and glass buildings strive for city skyline dominance, new technologies hold fantastic potential in enabling people to use these structures as instruments for human and artistic expression.

The Mood Conductor
Overview
To coincide with the London 2012 Olympics, the commercial sponsors of the London Eye, ran a public relations campaign titled 'Energy of the Nation'. As part of the campaign Cinimod Studio were commissioned to develop an installation which would allow individuals to represent their mood by taking control of the lights on the London Eye. The installation was named The Mood Conductor and over the course of three weeks it invited members of the public to use the motion of their hands to control the 320 lights that line the rim of the Eye (Figure 1). Participants were also given the option of wearing a pulse monitor that enabled their heartbeats to be represented as pulsing sections of light at the top of the Eye.

Design & Implementation
A single computer was used as the system controller, taking the heart monitor and motion sensor inputs and generating the lighting control signals for the Eye. We wanted the interaction to be simple, given the short amount of time which each participant would have to familiarise themselves with the installation. Hand tracking was implemented using a Kinect motion sensor positioned in front of the participant. The angles between each hand and the participant’s torso were then used to control the positions of two segments of lighting content on the Eye (Figure 2). Three separate styles of content were developed to reflect different mood states (Figure 3). A particular content style was chosen for the duration of each participant’s turn based upon his or her initial (first 10 seconds) heart rate and hand movements (Table 1).

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6 Term used loosely to include physical structures and landmarks
8 http://www.edfenergy.com/energy-of-the-nation/
Table 1. Content styles, their intended mood and the selection criteria based upon initial pulse rate and hand motion.

<table>
<thead>
<tr>
<th>Content Style</th>
<th>Intended Mood</th>
<th>Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pulse</td>
</tr>
<tr>
<td>Wave</td>
<td>Calm &amp; relaxed</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spectrum</td>
<td>Flamboyant &amp; creative</td>
<td>Med</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fire</td>
<td>Energetic &amp; aggressive</td>
<td>High</td>
</tr>
</tbody>
</table>

The heart monitor was custom built and consisted of an ear clip (placed on the ear lobe) and a matchbox-sized transmitter that was capable of sending data wirelessly to our system controller.

Analysis & Results

Over 1 million instances of data (captured 25 times per second) were collected from roughly 800 participants. The data comprised joint coordinates, pulse rate and content style. We carried out a broad analysis of the data that included spatial and kinematic characteristics of hand movements as well as behavioural observations relating to the types of gestures used and the influence of the lighting content.

In order to visualise the spatial characteristics of hand movements we generated histogram images. In Figure 4 the brightness of each pixel of the image is positively related to the amount of hand movement at that particular X-Y coordinate. Using a Mixture of Gaussian clustering algorithm we were then able to outline distinct areas where hand movement was most prominent (Figure 5).

We then compared the average hand velocity and heart rate for participants, separated by the content style they were interacting with (Table 2). The aim of this analysis was to explore whether the content style had an effect on behaviour. In particular we see that people interacting with the ‘Spectrum’ content style exhibit faster average hand movements and higher average heart rates.

<table>
<thead>
<tr>
<th>Lighting Content</th>
<th>Mean Hand Velocity (m/s)</th>
<th>Mean Heart Rate (bpm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wave</td>
<td>1.49</td>
<td>94.4</td>
</tr>
<tr>
<td>Spectrum</td>
<td>1.85</td>
<td>102.1</td>
</tr>
<tr>
<td>Flame</td>
<td>1.52</td>
<td>96.7</td>
</tr>
</tbody>
</table>

Table 2. For each content style the average hand velocity and heart rate is shown for all participants interacting with that content.

By using the joint coordinates to reconstruct and visualise hand movements we manually analysed the gestures which participants on the Mood Conductor performed. The result was a catalogue of 10 of the most commonly observed gestures, each with a short description and illustration (see Figure 6 for three examples).

In addition to data-based analysis we also used qualitative techniques, such as informal interviews and video recordings, to analyse peoples’ experiences with the installation. One of the most interesting observations was how, in the absence of any interaction instructions, people formulated their own rules and ideas about how the installation worked. When asked how it felt, participants reported a great sense of power when controlling the lights on the Eye.
Discussion
The use of histogram images (Figure 4) showed that the majority of hand movements occurred along a circular pathway centred on the participant’s torso. It may seem trivial to conclude that this was related to the circular shape of the London Eye. However, it leads us to question the extent to which more complex shapes might influence the perceived interaction space in situations where the gestural interface allows free movement.

Using quantitative measures (Table 2) we found that participants interacting with the ‘Spectrum’ content behaved differently to those interacting with the other two content styles. It is not possible to draw any definite conclusions as to why this was, however the ‘Spectrum’ content did exhibit more colour variation than the other two content styles. Despite lacking specificity, such quantitative measures could be adopted as tools for evaluating links between content and behaviour in future installations.

By cataloguing gestures (Figure 6) we were able to summarise how people interacted with the Mood Conductor. We were surprised by the frequency at which gestures re-occurred between nights and participants, especially in the absence of any instructions on how to interact with the installation. There was a tendency for gestures to be performed in the coronal plane, with relatively short and repeatable movements, which exhibited high degrees of rhythm, synchrony and symmetry. Qualitative measures such as cataloguing could enable interaction designers to develop their designs with knowledge of the types of gestures that may be used in a particular interaction situation.

Through our involvement with a public installation it was possible to obtain a large amount of data collected from a non-laboratory environment. The downside is that it is difficult to obtain any control data in order to carry out rigorous statistical analysis. This issue limited the extent to which we could investigate heart rate related hypothesis.

In conclusion, our study demonstrated the benefits of collecting and analysing data from interactive public installations. It is likely that such installations will become increasingly commonplace over the coming years. In response, interaction researchers and designers should engage in collaborative work more frequently, progressing our understanding and improving the quality of interactive experiences.

Acknowledgements
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References
The Challenge of Maintaining Interest in a Large-Scale Public Floor Display

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Abstract
Floor displays, because of the novelty of their location, can be more effective at grabbing the attention of passersby than public wall mounted screens. However, a concern is that as floor displays become more familiar, people will take less notice of them. We are exploring how to maintain interest in a large-scale interactive floor display in a semi-public university location. Our ongoing research involves exploring ways to enable participants to update the content of the display and seeing how effectively this keeps them interested. Firstly, we are making the floor display interactive so that participants can manipulate the content in real-time using whole body interaction. Secondly, we are encouraging the local community to generate content for the display.

Author Keywords
Floor displays; novelty effect; community engagement.

Introduction
People tend to ignore public screens [3], and when interviewed they explain their ‘display blindness’ by saying that they expected the displays to contain irrelevant content, such as advertisements [4]. Shah [7] carried out an observation of a public display showing a Reuters information feed in the foyer of the UCL computer science department (Figure 2) and found similar results: 74% of the people entering the building did not look at the display; 15% glanced at it for up to 2 seconds; and only 11% read the display for more than 2 seconds. In interviews people explained that they ignored the screen as the content did not interest them and that they would prefer departmental information rather than international news.

We hypothesised that using floor displays can be an effective way of capturing the attention of passersby in public spaces and may reduce ‘display blindness’ [6]. We argued that this is because: firstly, floors are an underused display medium and displays on this surface grab attention due to their novelty; and secondly, people do not have expectations about what information floor displays will contain. Consequently, we hypothesised that a floor display will increase people’s awareness of the information it displays. These hypotheses were tested by creating and evaluating an LED floor display that provided information about...
energy usage and occupancy of the different floors of the UCL computer science department. Over several days of observations, it was found that over 40% of passersby ignored it; 39% glanced at it for less than 2 seconds; and 21% looked at it for more than 2 seconds. On average people read the display for 26 seconds. The floor display was positioned near to two lifts (Figures 1, 4) and a demonstration of how engaging it could be was observing several people miss their lift because they were looking at the display. These results support our first hypothesis, namely, floor displays can capture the attention of passersby. Our second hypothesis was supported by the findings from questionnaires (n=20) that showed that 90% of respondents thought that the display had made them more aware of energy usage in the department. Finally, a new result, not previously noted in the public display literature, is that the way people engaged with the display was dependent on the time of day: first thing in the morning, the display was typically ignored (perhaps because this is a very busy time for staff and students, or because they arrive with a specific purpose).

Although the floor display was engaging over the short evaluation period of the energy usage visualization, a worry is that as people become more familiar with it they will pay less attention to the content it is displaying. An example of this habituation effect is the use of anamorphic speed bumps in Philadelphia (Figure 3), which look like 3D structures to approaching drivers even though they are flat pieces of plastic that are burned into the street. Initially, drivers slow down when they see the ‘bumps’ but the effect quickly wears off. Martin Pietrucha, an associate professor of civil engineering at Pennsylvania State University, commented on this finding: "We call it the novelty factor...They may get some mileage out of it until people realize, 'Hey, I don't get jigged like with a real speed hump.'" [2]. How can we counter short term novelty effects and maintain interest in a floor display? This is a research challenge that applies to all forms of public display. Our approach involves exploring ways of enabling participants to update the content of the display and seeing how effectively this keeps them interested.

**Enabling Whole Body Interaction**

We are installing sensors so that the floor display will be responsive to whole body interactions. People moving in the foyer area will be tracked by four Thermitrack thermal imaging cameras (http://www.thermitrack.com/) attached to the ceiling. These cameras will allow us to robustly track multiple participants as they are not affected by changes in ambient lighting. We are going to test the hypothesis that interactivity maintains interest in a floor display in a long-term behaviour change project, FloorPlay, that aims to encourage physical activity, specifically using the stairs instead of taking the lift in the UCL computer science building. Participants scan their university ID card at custom-built scanners on each floor of the stairwell, earning points for each floor they climb or descend. When they have sufficient points they can play on a large-scale interactive floor surface positioned in the same area as the energy usage display (Figure 1). Recent approaches in interaction design have emphasised the importance of fun in interaction design [Overb]. Encouraging behaviour change through playful interventions has shown significant promise [6]. Thus, one of the goals of this project is to leverage the motivational properties of games [1] to engage members of the university community.
The foyer floor comprises 288 light wells set in concrete (Figure 4). Whereas the energy usage display consisted of 16 light wells, the interactive floor uses 216 of these wells. Each contains a custom light unit (Figure 5) consisting of four RGB LEDs cut from an LPD8806 LED strip, joined together and mounted onto a plastic cap which fits neatly into the concrete surface from the floor below. The light units are connected in series, with three modified ATX power supplies providing power. An Arduino microcontroller connected to a Mac running Processing code is used to control the floor display. We are able to individually set each of the light units to one of over 2 million colours and update the whole array at a rate of over 25fps—effectively turning the floor into a large display with a resolution of 12x18 pixels.

We conducted a Wizard of Oz evaluation of two interactive games, where participant movements on the surface were manually tracked by the researchers. The two games evaluated were: a version of Pong where a single player's movements control a paddle in order to bounce a puck against the wall, and CatNipFun a game where one or more participants chase a moving light on the floor. If they reach the lit LED unit within 3 seconds the light moves to another position, otherwise the game ends. The two games demanded quite different physical interaction on the surface, the first requiring fairly moderate movements across one side of the floor and the other requiring much faster and larger movements. 20 participants from the university, a mix of staff and students, tried out both games. The majority found CatNipFun more engaging and they enjoyed the greater amount of physical activity the game required, often continuing to play until they were out of breath. Other participants showed a strong preference for interactions that required relatively little physical activity. Some participants felt too self-conscious to participate on the floor display in public. One said he would have been happy with a ‘Kinect-like’ interaction, where he would be able to make smaller body movements, such as moving his arms or leaning from side to side. In summary, many people found even simple games engaging and enjoyable because of the novel, large-scale nature of the floor display. Most participants were not inhibited by the public nature of the interactions, but there were clear individual differences regarding the preferred game.

Engaging the Community

Although making the surface interactive enables participants to change the display in real-time and potentially prolongs its novelty, the underlying content, whether games or information visualizations, does not change. We are therefore engaging the community in the building and encouraging them to help generate content for the floor display.

Participants in the Wizard of Oz study came up with a number of ideas for floor display games, such as an ‘Etch-a-Sketch’ system where their movements would draw images, and an implementation of ‘Twister’ where groups of players have to move their hands and feet to lights with randomly chosen colours. Many participants suggested that the Pong game would have been improved with a greater sense of competition with their peers which would involve having some sort of scoreboard displayed.

We are starting to engage with an HCI Student Special Interest Group (SSIG), which currently boasts almost 70 undergraduate and graduate student members from the UCL engineering and computer science...
departments. This group of students have programming skills and so they can not only generate ideas but also develop new content for the floor display. To facilitate this process, all of the code and hardware for the floor display is open source and freely available to the community. The floor display can be controlled using XML [8] and we intend to make a user friendly interface that enables non-programmers to generate content for the display.

**Summary**
Public display screens are often ignored by passersby whereas floor displays, because of the novelty of their location, can capture the attention of the public. One research challenge that we are addressing is how to maintain the interest in floor displays, as there is evidence that people can habituate to them. Our proposed solution is to enable participants to update the content of the floor displays. Firstly, we are making the floor display interactive so that participants can manipulate the content in real-time using whole body interaction. Secondly, we are encouraging the local community to generate content for the display. Our long-term behaviour change project will enable us to see how effectively these techniques maintain public interest in the floor display.

**References**


Pico Projection for Performative Place Based Services

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Abstract
In this paper we explore using handheld projectors in place of traditional location-based information services. We built a prototype system to compare performative projection of animations and images against conventional on-screen information. We conducted a user study to test the informative and the new performative design, gathering user feedback and reactions to the approach. Our findings highlighted design issues and the potential benefits of performative projection for prompting interaction with exhibits as part of the experience at a visitor attraction.

Introduction
The availability of mobile internet and realtime geolocation is increasingly allowing the information we seek to be linked in some way to the places we visit. Many of the mainstream location-based information services to date have focused on delivering images, multimedia or text in situ, direct from the internet to a mobile client. Of these services, there are multiple AR lens applications that make use of a camera, overlaying digital content on a realtime physical world image (e.g. see layar.com). However, while these systems can augment camera images with digital content, the user still has to hold their device in front of the real object – a digital divider between them and the physical world. The technology element is visible and in the way – it detracts from the magic of the experience.

By using pico projection, we can take this type of AR lens application one step further. By projecting into the environment rather than displaying on a screen, both the problem of sharing (screen size) and the existence of a digital divide (technology visibility) are compensated for. Instead of manipulating an image recreated on a device screen, we can now project onto the real world itself. Full-size projectors have been used on many occasions to augment buildings as part of a multimedia performance,
using 3D video mapping to make the buildings appear to come to life (e.g. see nuformer.com). With pico projectors we can create a similar display while mobile, but rather than simply informing the user of relevant digital information, we can allow them to become part of the performance itself.

In this paper we report on a prototype system to display pico projected images and animations. The novelty of this work lies with the use of pico projection to augment exhibits at a visitor attraction. In particular, there was a large emphasis on the user being able to control the placement of the projections in a free-form way, positioning projections using a red dot, preventing the need for a sophisticated tracking system. While some of the findings have been seen in prior works, the performative perspective of this research sheds new light on the possibilities.

**Background**

In recent years, there have been multiple attempts at developing mixed reality experiences for groups of people to share. The ‘Augurscope’ [5], for example, was an early outdoor mixed reality prototype for groups of people at an attraction. Small mobile screens are good at displaying private and personal information, but this also makes them very poor at displaying public information to groups of people. In recent years, researchers have experimented with various solutions of presenting public information on a public display using personal mobile devices [2].

Pico-projectors now enable mobile devices to show a much larger display than that of a laptop or other mobile device. Researchers have been quick to take advantage of these devices in mobile information scenarios, using projectors for collaborative learning [3] or gaming [7]. Our prototype is inspired by these previous designs, but we focus on the collaborative, shared viewing experiences possible when using public mobile projection (such as [2]).

Bongers was one of the first to realise the potential of taking the projector out of its intended context [1]. In considering potential research directions, he concluded that it would be “very interesting to create a location-based instrument that projects images and sounds depending on the spatial context of the performer”. Wecker et al. developed ‘Pathlight’ [6], a handheld projector experience that helped visitors navigate a museum using projected arrows (on either the floor or wall) depending on the user’s location and orientation. To our knowledge, our implementation is the first to focus on location-based curated content, providing a handheld interactive projection-augmented experience that can overlay exhibits at a visitor attraction.

**Prototype**

We developed a mobile prototype to demonstrate performative, place based projection. We worked with the curators of a popular tourist location—a national botanic garden—carefully crafting and tailoring the types of performative projection specifically to the context of their visitor attractions. Our system reuses QR codes and some curated content from a previous project at the gardens (similar to [4]). We use QR codes for location awareness.

For this research, our main aim in using a pico projector is not as extra screen space, but specifically to allow a visitor to augment the real plants and objects with digital content, acting out or performing actions with the elements they project. In the context of this paper, we define performance as manipulating the projections to achieve effects with the projected content. Where
spectators are present, the moving and positioning of the projector and the effect can create an illusion of AR. Our system uses an iPod touch attached to a pico projector (see Fig. 1). The iPod is used to scan QR codes situated next to eight exhibits around the gardens’ visitor centre. After scanning, an image and sentence of context about the exhibit are shown onscreen, along with a prompt to focus a projected target on the object. The user presses a button when ready, and imagery or animation is then projected. Figure 2 shows several such examples, where the projection appears next to or on top of the related artefact. Apart from the initial QR scan, the system does not implement any additional tracking. This allows users of the system to project freely onto objects in an attempt to promote performative and playful behaviour.

Informative, screen-based system
We also built a second, alternative mode into the system, allowing us to compare traditional screen-based location information with the projected content approach. After recognising the QR code and showing the same initial content on-screen as in the performative system (i.e. a sentence of context and an image), upon pressing a button it then displays a page of textual information about the object, instead of a projection (see Fig. 1).

Field trial
We conducted a study over six days at the botanic garden. The aim was to test both systems with real visitors in situ. We had two research questions:

RQ1: How do perceived learning and enjoyment through performance with projections compare to perceived learning and enjoyment with text-based information?

RQ2: How does the performative aspect of the projector system affect involvement or interest from non-participant visitors when compared to the informative system?

Participants
Twenty groups of participants were recruited as they entered the building. Ten groups used the informative system and ten used the performative system. A total of 58 participants took part, with 34 people using the informative and 24 using the performative system. Participants’ ages ranged from 3–80, with 29M, 29F overall, and similar gender distribution between systems. The average group size was 3 participants.

Measures
To gather users’ opinions of the system a short survey was built into the prototype. After scanning a QR code and either projecting or reading the related content, the prototype prompted the group to give feedback. Groups were instructed to give feedback collectively. The survey questions asked: 1) how many non-participant visitors stopped to look; 2) participants’ enjoyment; 3) perceived learning value; and, 4) how they felt their understanding was affected in each location.

Questions 2 and 3 allowed participants to select a rating from 1 (low) to 5 (high). Q4 allowed a selection from ‘decreased,’ ‘unaffected,’ and ‘increased.’ In addition to the survey, participants answered a short semi-structured interview at the start and end of each session. For one of the six days, two additional researchers observed groups’ behaviours from a distance while they used the prototype, being careful to avoid intruding on the experience. In total four groups (13 visitors) were observed, with three using the performative and one using the informative system. In addition, during that day, many visitors who were not participating in the study were also observed.

Procedure
After groups agreed to participate, a short training session was conducted to demonstrate usage of the system to the
group. The group was then given the prototype (in either performative or informative mode), and an information sheet in case they needed further guidance. This sheet also incorporated a map showing the approximate location of eight QR codes to scan (see Fig. 3). The group then left the researcher, finding and scanning each separate code and completing the five survey questions after viewing the content associated with each display. At the end of each session, the group were debriefed in a short post-study interview, thanked for participating and given a gift voucher.

Results
Considering first the data gathered by the mobile application after each exhibit. For Q1, the average numbers of non-participant visitors that were reported were 1.39 for the informative system (sd: 1.66) and 1.88 for the performative system (sd: 2.33). There is an overall significant difference in participants’ rating of whether their understanding of an exhibit was affected (Q4), with the informative system seen to be more beneficial in that respect ($p < 0.002$; Mann-Whitney). Turning to the ratings of enjoyment (Q2) and perceived learning (Q3), there was no significant difference between systems.

In the post-study interview, all participants indicated that they had noticed interest from other non-participant visitors around them. A common sentiment was captured by one participant, who said: “if people were around they looked.” In some instances, other visitors were curious enough to ask participants what they were doing. Three groups using the performative system reported that they demonstrated the system and engaged with non-participant visitors. One of these said that their performance involved 13 visitors who became interested in what was happening.

Participants often commented that the system they used added interest to their visit, with one participant claiming that the performative system gave “an extra dimension.” Some of the groups with children (using either of the systems) noted the enjoyment in seeking out and scanning the QR codes themselves. One participant using the informative system explained this, but noted: “the children love to find the codes and scan them but they’re not interested in reading any of them.” Several participants commented that the brightness of the projector was sometimes an issue.

Observations
Considering first the group observed using the informative system (four adults; one child) – in general this group gathered closely around the system after scanning each QR code. No single individual in this group took control of the prototype; instead, participants took it in turns to scan each QR code. In some cases one participant read aloud to the rest of the group; for other exhibits individuals read to themselves instead, huddled tightly around the device. While other visitors were aware that the group were doing something unusual, they were not seen to experience the information the group was reading.

With the performative system, where three groups were observed, there was evidence that projection encouraged participation beyond the device itself. Participants were not gathered around the device, but were seen to be focused on the projections rather than the prototype. In one group (two adults; two children), an adult held the device and let the children direct his hand, pointing the projections at plants while visitors stood by and watched.

Discussion
The higher rating given to the informative system in terms of “understanding” is not surprising given that the system
provided detailed textual content for each exhibit, in contrast to the performative system’s images and animations. We might have expected a higher rating for perceived “learning” in the informative version for similar reasons; and, conversely, a higher rating for “enjoyment” for the performative. However, no significant effect was apparent. For this reason then, we may speculate that both types of system provide benefits in these respects—allowing for both informative and performative modes in future designs would seem a sensible approach.

Clearly image quality, particularly brightness, impacts on the efficacy of projection. Visibility seems to have played a part in participants’ opinion of the performative prototype as a learning resource. No significant difference was found in the numbers of people reported as stopping to watch by participants using both systems. However, post-study interviews and group observations suggest that bystanders had a more active engagement with the performative prototype.

Conclusions and future work
A pico projection system, such as the one employed here, may encourage people to engage with their surroundings rather than focus on signage or, if using a conventional mobile device, the device itself. Furthermore, there is some evidence that projection might allow groups to enrich their shared experiences and to draw in bystanders.

The choice of locations and attractions for performative projections can clearly impact on the effectiveness of the approach. Forcing visitors to stand in “disruptive” locations to project content—for example, changing the flow of others along a pathway—may encourage spectators. Careful stage-craft is needed, though, to avoid annoying bystanders or embarrassing performers.

Pico-projection brightness will remain an issue for some time. To accommodate this, and to further use digital output to prompt physical engagement, we might consider providing more stage direction to users. For example, in the garden context, instead of simply asking people to target the beam on an exhibit, the group could be asked to stand round the plant (providing shade), with one of them cupping their hand around a leaf (further darkening the object) before animations begin.

References