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Exploring the Effects of Space and Place on Engagement with an Interactive Installation

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ABSTRACT
Very little research has concurrently explored the influence of both physical space and social context (or place) on the way people engage with a public interactive display. We addressed this issue with a novel approach: studying how people engaged with the same interactive installation in ten situations with varying spatial and social properties. The main finding across these studies is that place trumps space: an conducive social context could overcome a poor physical space and encourage interaction; conversely, an inappropriate social context could inhibit interaction in spaces that might normally facilitate engagement. We discuss this finding in terms of the salience of the display within the space, the visibility of incidental interactions with the installation, the different understandings of place that people can have in the same location, and the role of emergent champions and competitors in encouraging interaction.

Author Keywords
Public display; situated display; space; place; interaction.

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

INTRODUCTION
Novel forms of interactivity are increasingly being developed for large screens and media façades that are deployed in public spaces. Understanding the nature of public engagement with these displays is important for their successful design. The challenge is to grasp how they capture the attention of passers-by, make people aware of the mode of interaction, and encourage them to engage in interaction given both the physical properties and social context of a location [17, 5], a contrast that we characterise as the effects of space and place in this paper.

The concepts of space and place are well known in HCI [8]. Space is commonly described as the geometric structure that enables or constrains certain kinds of behaviours, whereas place refers to the ways in which the space gains social meaning over time through interactions within it; thus place includes the memories, experiences, norms and patterns of behaviour associated with a space. Ciolfi [3] has called for new design methods to understand the human experience of place in designing for ubiquitous technologies that are embedded in specific locations.

This paper aims to understand the relative contribution of space and place in the success of an interactive display. To address this question, we took a novel approach, carrying out ten exploratory field studies where we installed the same interactive installation in different locations that varied in their spatial properties and social contexts. The focus was on the behaviour of passers-by in the immediate vicinity of the installation. We observed how people engaged directly with the installation, and how they collaborated and interacted with one another when engaging with the display and while spectating. In the next section we detail related work on the role of spatial and social factors on engagement with public situated display technologies.

BACKGROUND
There is an increasing prevalence of screens and projections in public spaces, such as situated information displays, video advertisements and media façades. In addition to these passive information and entertainment platforms, we are starting to see novel forms of interactivity being implemented to engage passers-by in interaction with screens and media façades. Real-world deployments of interactive displays include CityWall [20], Worlds of information [12], and Magic Mirror [15]. A media façade is an installation or display integrated into architectural structures [7]. Large scale façades can cover an entire building front, using digital projectors, (e.g., [1]) and although they currently tend to present predetermined feeds, such as video, some are interactive, such as SMSSlingshot [5].

Designing and situating public interactive displays is difficult because passers-by often come across them incidentally. Müller et al. [17] outline three challenges in engaging passers-by in interaction: initial engagement; ongoing engagement; and the public nature of the engagement. They suggest that many displays fail to sufficiently attract attention from passers-by, and if they do, many fail to motivate people to interact. Furthermore, interactive displays often fail to deal appropriately with the social inhibition associated with interaction in public.
Initial engagement is challenging as people generally expect displays to show uninteresting content such as advertising - a phenomenon called ‘display blindness’ [18] (cf [11]). However, social activity can play a role here: the physical presence of others interacting can draw attention to and encourage interaction with displays, which is known as the ‘honey-pot effect’ [2].

Observers can learn how to interact with a display or installation from others, for example through cooperative exploration or by first observing others before attempting to interact, often leading to chains of interaction [20]. Social learning occurs only if spectators can see the effects of participants’ actions on the screen and is strongest when both the manipulations and the effect can be seen [20].

There are also social situations where a participant engaged in interaction is not just interacting for themselves, but is also performing for an audience and is encouraged and motivated by their reactions. However, an unfamiliar audience can also discourage interaction and create a sense of social inhibition for some people [19]. This barrier can be overcome through encouragement by ‘comperes’ who legitimise participation by members of the public. The compere can also explain what is going on to people in the vicinity of the interaction, helping to reduce uncertainties about how to get involved. Finally, a compere can provide a running commentary that can enhance the spectators’ experience [19].

The spatial configuration of interactive displays can also influence whether they are used. Ten Koppel et al. [22] explore ‘chained displays’ (flat, hexagonal and concave arrangements). They found that the flat arrangement created the largest honey-pot effect and fostered social learning. A hexagonal arrangement allowed strangers to comfortably engage in interaction on adjacent screens and a concave arrangement created the lowest level of simultaneous interaction by splitting groups into actors and audience.

The architectural theories of Space Syntax [9] provide designers with a set of methods to analyse the social “affordances” of space: the ways it structures actions and interactions. In particular, Space Syntax analyses spaces in terms of both their connectedness to other spaces and in terms of the geometry of visibility. These same theories have also begun to be used to explore how measures of physical space might be used to position public displays to maximise their visibility and information pickup [4, 5, 21]. Related work by Marshall et al. [13] has suggested that interior design structures can influence the social interactions that occur within a space, a view that Hornecker [10] characterises as ‘embodied facilitation’.

Issues of scale and the spatial organisation of context and environment are rarely considered but from their observational studies of interactive media facades, Fischer et al. [5] define physical and social spaces relevant to the design of interactive displays. Physical features like walls or pillars can provide ‘comfort spaces’ for people to view the display, while protected from interaction themselves. ‘Activation mosandspaces’ are non-interactive spaces from which the display can be seen, potentially generating interest.

Previous research has only looked at a single location (e.g., [20]) or at different kinds of displays in a variety of different locations (e.g., [11]). We therefore know little about the relative contribution of both space and place on engagement with interactive public displays. In the next section we detail the exploratory fieldwork approach that allowed us to seek answers without being constrained by prior theory.

METHOD

To investigate the relative contribution of space and place to the ways that people engage with an interactive installation, we carried out an exploratory field study where we installed the same system – Shadow Wall [6] – in different locations that varied in their spatial properties and social contexts.

Shadow Wall

Shadow Wall is an interactive display that captures the shadows cast by people as they move in front of a projected white screen. The recorded footage is processed in real-time to generate a movie of the movement. Every time a new movie is created, it is blended with those generated by previous participants and projected onto the screen, creating a dynamic collage from the history of interactions with the system. Shadows generated by earlier interactions with the system are made more transparent (light grey) and more recent interactions are darker (Figure 2). The work was commissioned for a music festival in Brighton, UK, (Loop 2008) and has also been displayed in a gallery setting. It was chosen as it had been found to be very engaging in these contexts: “[t]he wild dancing and cartwheeling it inspired was performance art in itself” [14]. The system was initially developed by Gareth Hallberg [6] and re-programmed for the current study by Jon Bird.

The system (Figure 1) comprises a projected display, a proximity sensor that detects when people are in front of it, a camera that records the shadows, and a controlling computer. When a person is detected in front of the screen, the system projects white light so that they cast shadows, which are recorded by the camera. When the person moves away, or after 8 seconds, the system creates a composite movie of the captured shadows and displays it.

![Figure 1: Typical Shadow Wall setup](image-url)
Participants find the system engaging for a number of reasons. There is the immediate enjoyment of casting large shadows on the screen. Then there is a short (1 or 2 seconds) delay between the system finishing capturing shadows and the display of the new composite movie which generates anticipation in the participants about how their shadows will appear in the new layered shadow movie. The camera is purposely placed so as to slightly distort the image of the shadows, which adds an abstract quality to the display. Furthermore, as more shadow movies are overlaid in the composite movie, it can be harder for individual’s to identify their own shadows. For this reason, participants learn to perform exaggerated movements to ensure they are visible. If a group is interacting around the display, there is often spontaneous cheering and shouting when somebody’s shadows are particularly visible in the movie.

**Locations**

Shadow Wall was installed in six opportunistically selected public locations. Three were within a university campus, whilst the others were non-academic locations — a skate park, a dance studio and a clothes store.

The *Engineering Building Foyer* is a semi-public university space. Windows span one side and equally spaced pillars on the opposite side create a passageway leading to the far corner where there is access to two lecture theatres. Students, academic faculty and other staff pass through the space en-route to and from the lecture theatres, upper floor offices and other parts of the building throughout the day. Shadow Wall was installed when both an Open Day and a Women in Engineering and Technology (WET) event were held in the foyer.

The *Campus Cafe* is a ground floor rectangular space, divided into different sub-spaces through the arrangement of a canteen counter, tables and chairs and physical pillars. Shadow Wall was installed on a standard weekday, when there were no special events taking place in the space.

The *Cloisters* is a large, wide hallway and irregularly shaped intersection to different sections of the main university building. This is a public space that visitors can freely walk around. The space is fairly empty, and so hosts different functions such as exhibitions or rehearsals. There are several access points leading to the main Quad and also access to a roof garden. Shadow Wall was installed when an Outdoor Screening event occurred just outside on a Friday evening and also on a weekday evening when a Summer Party event was held in the space.

The *Skate Park* is one of the largest indoor skate parks in Europe, holding up to 600 children and adults. The park is designed to be an exciting, family friendly space, but is also used by professional skaters. The majority of visitors come in groups, and there is a mix of amateurs and professionals. Two studies were carried out here, one on a popular skate ramp and another in a semi-public social space, located near the entrance.

The *Dance School* provides classes and studio space for both amateur and professional dancers. A one-day study was carried out in a square lower ground floor waiting and cool down area adjacent to the female changing rooms.

The *Clothes Store* is popular clothing retailer on the busiest shopping street in London, UK and is marketed at a young clientele. There were no empty spaces on the shop floor itself, so Shadow Wall was projected onto a clear white wall spanning the length of the space adjacent to the men’s fitting rooms, located on the lower ground floor. Two studies were carried out here.

Comperes [19] were used to encourage participation during two studies: the WET Event in the Engineering Building Foyer and the Clothes Store. There was no compere at the other locations, which meant that interaction with Shadow Wall was initiated and managed by people who passed through or occupied the space. However, informal champions of the system emerged at the Summer Party event and at the Dance Studio, as we describe in the Results section.

**Data gathering and analysis**

A rapid ethnography [16] was conducted over four weeks, comprising 10 days of observations. 1647 people were observed engaging with Shadow Wall to varying extents. On each of these days, qualitative observations were carried out. This involved making field notes and sketches and taking photos where possible. Where appropriate, interviews were conducted. Shadow Wall was shown for different lengths of time, depending on negotiations with gatekeepers or the duration of the event. Observations at the different locations were carried out at various times of the day, on both weekdays and weekends and focused on the behaviour of passers-by in the immediate vicinity of the installation.

Shadow Wall stored the shadow sequences from each interaction along with a timestamp. These videos acted as logs for interactions directly in front of the installation; the data were used for further analyses. This allowed repeated inspection of particular behavioural episodes.

30 participants (with a broad range of backgrounds and ages) were interviewed in situ during observations, each for between 5 and 10 minutes. The majority of interviewees had noticed the researcher writing field notes. Some interviewees were alone, others were members of groups, and

![Figure 2: A still from a movie generated by Shadow Wall. Darker shadows are from more recent interactions; lighter ones from older interactions.](image)
they were in the locations for a variety of different reasons (including attending events, work and shopping). Interviews were kept open-ended so new insights could be discovered. Responses were written rather than recorded because of the social circumstances of the “in the wild” interviews.

Field notes and images were analysed after each study and qualitative themes were defined, which were tested and developed in subsequent studies. Key findings are described for each of the ten studies below.

RESULTS

Study 1: Engineering Building Foyer Open Day

The space was used as the engineering faculty’s presentation area for an open day. Several demos were on display and information booths were arranged in the space for visitors to find out more about different courses. Shadow Wall was installed on the back wall of the foyer in a salient position. An interaction zone between the projector and the wall was kept clear so that visitors could incidentally discover the interaction.

The installation was highly visible: passers-by noticed Shadow wall from several locations. Stationary groups in the vicinity were also observed discussing what the installation could be for. However, despite being aware of the installation, people seemed uncomfortable standing in front of the projector. If they did walk through the interaction space, they moved quickly and acted as if they were doing something wrong.

As there were few interactions with the installation, most of the audience was unaware of how to interact with the display or even that it was interactive. Those who were interviewed thought the projector was displaying an abstract image and that the space in front of the projector was to be kept clear so as to not occlude it. This misunderstanding created a barrier to entry and there were no interactions until the arrival of Group A.

Group A were three colleagues of the primary researcher who had come to try out Shadow Wall. Their interactions generated a honey-pot effect where there was a progressive increase in the number of people looking at the installation. Group A began with subtle interactions – small gestures and movements – within the interaction zone and these caught some people’s attention. As Group A engaged in direct interaction, with bigger, more expressive movements, a ‘sociable buzz’ developed, with more people in the immediate vicinity looking towards the display, moving closer and discussing it. For a short period, Group A engaged in multiple interactions and most people nearby became spectators of the movements Group A made and the shadows they cast.

After they left, several people approached the primary researcher to ask about the installation. However, despite their curiosity, they were reluctant to engage with it themselves, seemingly intimidated by the social context. For example, one interviewee explained, “I don’t know anyone here. Maybe I’ll have a go when it gets quieter”. There were no more deliberate interactions with the installation, but the honey-pot effect resulted in an understanding of the installation and noticeably more people now comfortably passed through the interaction zone rather than skirting around it.

Study 2: Engineering Building Foyer WET event

Shadow Wall was projected onto the inner wall of a passageway in the foyer defined by equally spaced pillars. The shape of the area from which this part of the foyer is visible is quite irregular (cf. [4]), broken up by pillars and corners. Passers-by naturally walk through this space when they are moving between lecture theatres and the stairs or the building entrance. The WET event was a day of lectures and demonstrations, enabling schoolgirls (aged 16-18) to discover more about careers in engineering. The foyer was set up as the informal breakout and eating area for the event. The eating area directly faced the installation, which was in a salient position, framed between two pillars. In interviews participants indicated they were self-conscious in the environment and wanted to make a good impression.

Typical paths through the space encouraged incidental interactions, allowing onlookers and passers-by to discover the interactivity of the installation as the shadows of passers-by were captured. As the WET visitors entered the foyer from the lecture theatre, the first participant who entered the space took the most natural route to the table of food, passing between the two pillars where the installation had been set up. She initially hesitated in front of the projector but with limited options, continued walking. The projection went white as she entered the interaction zone and others, noticing this, followed suit. A queue for food formed directly in front of the projector and when the time went over the recording limit, the Shadow Wall began to display the cast shadows. This caught the attention of several visitors who turned to face the display as they waited, some of whom pointed at the shadows that had been recorded. Curiosity increased as people socialised in the eating area. They noticed and reacted to the effects of several incidental interactions. Shadow Wall became a talking point between groups. However, the students were very reluctant to interact directly with the display and it was only used by the staff who were involved in the organisation of the event and a single group of students who were encouraged to use it by a member of staff who acted as an informal compare. Several staff groups, mostly in pairs, engaged with Shadow Wall, first with a subtle interaction, either by just standing in the space or waving their hands. They repeatedly moved to the sides to view the effects then returned to the interaction zone making bigger and more expressive moves before discussing them with colleagues.

Study 3: Campus Cafe

The Campus Cafe is a rectangular ground floor space, divided into different sub-spaces by the arrangement of tables and chairs. Shadow Wall was installed in the central space
of the cafe accompanied by explanatory posters that encouraged people to interact with it. This was an area of high footfall, close to two entrances to the Campus Cafe. Passers-by needed to go through this space to the canteen counter or various sitting areas, or to the second doors (a common route).

Shadow Wall directly faced a space in which comfortable sofas and large coffee tables were arranged. The study was carried out at lunchtime. People could be seen having informal meetings, socialising in groups, or alone reading or interacting with various mobile devices while they had their lunch or over coffee. Children and parents were also present in the space.

Groups could be seen and heard discussing what Shadow Wall might be displaying, noticeably looking at the display as they spoke. The positioning worked to encourage incidental interaction from passers-by. Onlookers were able to quickly understand the installation's interactivity by identifying the silhouettes of passers-by within the cast shadows displayed. Despite curiosity about the installation, being seated seemed to create enough of a barrier to entry to prevent these onlookers from trying it out.

In contrast, for passers-by, the shift between a white screen projection when they entered the space and the return to displaying a composite shadow movie when they left the interaction zone seemed to correctly communicate the interactivity of the installation; several passers-by who entered the space engaged in very small subtle interactions, moving through the space slowly and then turning towards the display to see the effect. With high footfall during the lunchtime rush, it was not possible to stand around in the space and so passers-by did not normally stop to view the moving images for long, although some people tried to view the impact of their movements on the display for as long as possible as they walked away from the interaction zone. One participant waited near the door, viewing the installation even though he had to constantly change position to allow others to pass. When he recognised his silhouette within the display, he signalled to his friends to take a look before they moved on. If passers-by engaged in subtle interaction, and did not see the effect they expected, interaction usually ended.

During the lunchtime study, the installation seemed to work well with children who engaged in direct interaction without necessarily understanding the interactivity. They perceived the installation to be something to play with. One child noticed the light beaming from the projector and responded by playfully running toward it, attempting to put her face directly in front of the projector before her parents pointed her to the wall. Noticing her shadow, she began to dance. Her parents seemed to be in a rush and so the interaction was short and they didn’t wait to see the effect, but it was long enough to create a honey-pot effect that attracted a young boy to interact with the installation. Having seen the girl dancing in front of the display, he pointed it out to his parents and tried to break free from his mother’s hold before being given an opportunity to play with the installation, while the parents put a baby into a pram.

**Study 4: Summer Party**

The hallway of the South Cloisters was used for the Computer Science Department’s Summer Party event. Entertainment was provided in the space: at one end of the hallway there was a photo booth with costumes and Shadow Wall was projected onto the inner wall at the other end. Soft drinks and alcohol were provided, along with an ice cream stand and barbeque in the adjacent roof garden. The event was relaxed, sociable and fun. Groups chatted and joked and work social norms were slightly altered due to the consumption of alcohol.

Between 5pm and 6pm passers-by not attending the event were finishing work for the day. Many walked by with their heads down, e.g. casually reading a book, or rushed past in order to leave the building. If a passer-by was preoccupied as they walked through the interaction space then the display effectiveness was reduced. Only 16% of passers-by viewed or reacted to Shadow Wall during this period. Between 6pm and 7pm, when people began arriving for the CS party, this rose to 81%.

The addition of alcohol, food and entertainment seemed to give permission for playful behaviour with Shadow Wall. The social configuration of the space supported prolonged engagement and people took their time and seemed more comfortable engaging in subtle interaction. As participants viewed and reacted positively to the effects of their interaction they would often become more expressive in their movements. This was noticeable in an episode of interaction by a group of 3, GroupB. They first engaged in subtle interaction, waving their arms and stepping back to observe the result; they then engaged in more expressive interaction, each member casting a shadow, from Egyptian dancing to star-jumps or attempting to pat the head of a friend’s shadow. A honey-pot effect soon emerged with a noticeable increase in the number of people within the immediate vicinity of Shadow Wall.

Different spaces, similar to those described by Fischer et al. [5] formed: an activation space where people observed was created by a second group, GroupC, as they stood watching. A member of GroupB played a key role: without any prompting she took an active role in encouraging others to interact and became an emergent champion. She was the most expressive in her movements and verbal reaction to the Shadow Wall and co-ordinated others in group interactions by suggesting creative shadows to cast. The emergent champion invited GroupA to join them, but they stayed in an adjacent space where they could safely socialise with GroupB without interacting themselves (cf. Fischer et al.’s [5] comfort spaces). As time went on and GroupC continued to observe, social learning was achieved, their confidence increased and as the champion shouted out “Jazz hands”, GroupC joined GroupB in the interaction zone.
When interactivity sufficiently engaged the audience that champions emerged, the group interaction experience was noticeably more lively. The duration of the group’s interaction was also longer: Group B interacted with Shadow Wall for 16 minutes and they returned several times.

However, just as an emergent champion could encourage interaction from nearby spectators, they could also discourage new groups from approaching the vicinity of the display. During Group B’s interaction, several groups formed to watch them. Some did not seem to know the members of Group B and so waited for a while before moving on. These groups may have wanted to engage in interaction but felt they had to wait their turn. Members of Group B did know Group B, but still waited until they had left to interact with the installation, seemingly intimidated by their enthusiastic engagement. When Group B left the installation after a second period of interaction, a chain of interactions followed. Several spectators who had been waiting returned to the interaction space and engaged in short interactions.

**Study 5: Outdoor Screening Event**

Shadow Wall was projected onto a wall close to the intersection space of the Cloisters, a point visible from an irregularly shaped area, with several access points to the Quad and various parts of the main university building. As with the previous study, initially people rushed through the space as the working day ended. Later, the space began to fill with excited people as the Cloisters was a main route to a large outdoor screen that had been set up to show the opening ceremony of the London Olympic Games. A bar and food stalls had also been set up just outside. Passers-by were laughing and joking, ready for some Friday fun. People viewed and reacted to Shadow Wall as they walked through the Cloisters space from areas where the installation was most visible. Incidental interactions from other passers-by were instrumental in attracting attention. As the night progressed and the event got under way, excitement increased, passers-by were louder and were much more expressive in the interactions, but with less of an audience to observe them as most people were outside, engagement was not prolonged and interactions were short with no groups forming around the installation for long periods as had occurred at the CS Party.

**Study 6: Skate Ramp**

Shadow Wall was projected on to the back wall of a popular ramp in a far section of the park. It could only be seen by visitors adjacent to it, given the irregular shape of the space. Thus, the structure of the space was not considered to be optimal for encouraging engagement.

However, Shadow Wall was very popular in this location: skating is an active movement-based sport that lends itself well to shadow ‘action replays’. As skaters discovered the interactivity, they began to appropriate it as a tool to visualize their own tricks. They would perform a trick, wait on the platform to see how it looked on the display and repeat it until it looked right. Groups formed nearby and could be heard discussing what the cast shadows looked like and what the individual needed to do to improve them. When their parents came into the space to check on them, several participants showed their parents the installation and their silhouette, using it as a tool for showing off and demonstrating their skill.

**Study 7: Breakout area with lockers**

The breakout area (Figure 4) is a semi-public area of the park: an open rectangular space and the initial entrance space before entering the ramp area itself. Shadow Wall was projected onto a wall directly facing the seating area, mainly used by parents who sat reading newspapers or chatting as they waited. The installation could also be seen from a locker area (Figure 4) where groups often gathered. The installation was in a salient position and visitors would incidentally interact with it as they made their way to the main ramps (Figure 4 shows the typical paths followed).

As described in studies 4 and 5, if participants were preoccupied as they passed through the interaction space, display effectiveness was reduced. Many passers-by were preoccupied with riding through the space and did not look at the
display. However, this changed if a larger group moved through the space: several times we observed an individual recognising the silhouettes on the display and pointing this out to the rest of the group. They then engaged in interaction on whatever they were riding (scooters or skateboards), doing tricks as they made their way to the ramps.

Again, just like the CS party, the skate park breakout area provided the social affordances for fun that seemed to provide a ‘licence to play’ for those observing incidental interactions while sitting in the space. For example, a parent, sitting in the breakout space and spectating, moved to sit closer to the locker space. He continued observing the incidental interaction of passers-by before getting up to give it a try, doing a dance-walk from one end of Shadow Wall to the other and back again. As his children arrived, he directed them into interaction with Shadow Wall.

Study 8: The Dance School
Shadow Wall was installed in the chill-out and warm-up area of The Dance School, a square space on the lower ground floor with access to the female changing rooms. Windows span one side of the space, looking out into one of the dance studios. The installation was positioned so that it was visible from the door and en-route to the female changing rooms.

The placement of Shadow Wall did not encourage much incidental interaction from passers-by and many people who walked past it remained unaware it was interactive. From comments made by passers-by, it was evident that some people believed the display was a projection of an abstract performance art piece. Many commented on how beautiful the dance silhouette was and several people stopped by the door to admire the art.

Staff were told about the installation and after some initial performance apprehension, they interacted with the system and became emergent champions: on returning to the reception desk, they told fellow staff and regular members about the installation, leading to more people – mostly groups of fellow staff, professional dancers and teachers – coming to the space to cast their own shadows.

Most members only became aware of the installation through the emergence of another honey-pot effect. People waiting in the space for their class to start became spectators as they observed the staff, teachers and professional dancers engage in interaction. They viewed, pointed at and discussed the cast shadows, but many were reluctant to engage when prompted. Only two onlookers had a try and they were professional dancers. Several of the amateur dancers mentioned performance anxiety when asked why they didn’t participate. The shadows cast by the professional dancers and the unfamiliarity of the space were social inhibitors; there was a fear amongst amateurs about spoiling the ‘art’, and they felt that the professional dancers would judge their performance. Amateurs only spectated, even though some wanted to have a try. For example, in one of the interviews, a spectator stated she would use it in another dance venue because, in contrast to this dance school, “it’s a have fun, and make fun of yourself kind of place”.

Study 9: Clothes Store, Saturday
During the week when the space was being prepared for the installation, several staff members had asked about what was being installed. By the weekend of the study, staff were eager to see the results. Socially, the laid back nature of the store allowed Shadow Wall to work well. Fitting room staff were the first to engage in interaction. They then became emergent champions for the installation, introducing and demonstrating the installation to customers as they waited to use the fitting rooms. Throughout the day staff members who engaged in interaction told other colleagues, leading to groups coming down to the space to see and engage with the installation which resulted in chains of interaction.

New staff members gathering to view the interaction going on within the space generated a honey-pot effect where customers waiting to use the fitting rooms also became spectators. When the group within the interaction zone returned to their work, small groups of staff who had been spectating entered the interaction zone and directly engaged in interaction. Many of these groups seemed to have planned what they wanted to do, sorting out where to stand and giving a signal to co-ordinate their movements (Figure 5). New groups of staff eventually stopped arriving, leaving only the waiting customers. Customers typically moved into adjacent spaces to get a better view of the installation in the constrained space next to the changing rooms, but tended not to directly engage in interaction. The fun, expressive silhouettes in the display seemed to create a social barrier: customers may have felt they needed to continue in a similar vein and may not have felt confident or comfortable doing this in the public setting of the space. Customers engaged more in subtle interactions when Shadow Wall displayed less expressive movements.

When customers made their way to a fitting room, they would often incidentally interact with the installation. On leaving, most would have their head down, putting clothes on.
on hangers or sorting out the clothes they wanted, and they would often not notice the cast shadow of themselves. As with studies 4 and 5, when individuals were preoccupied they did not engage with Shadow Wall as they passed through the interaction zone. However, if they were in a group, then, as in the skate park study, someone usually noticed the interaction and pointed it out, resulting in the whole group returning to the space to view and react to the effect, and then, engage in interaction.

**Study 10: Clothes Store, Sunday**
The store was quieter than the previous day and because there were fewer staff less of a honey-pot effect was generated. Shadow Wall therefore relied on customer awareness of the interactivity and the installation was not very effective. To see if this could be improved, an in-the-wild experiment was conducted. The previous day had shown that individuals in groups were more likely to discover the interactivity, as a trailing member would notice their group’s silhouette and point it out, resulting in the initiation of group interaction. We decided to find out what would happen if individuals were made aware of the interactivity by showing them the shadow cast from their incidental interaction. We wanted to see whether customers would be curious enough to go back and view their own silhouettes and whether the social context would then encourage and motivate them into engaging in subtle interactions. If a customer had not noticed their silhouettes when leaving the changing room, staff, acting as comperes, would draw the customer’s attention to the installation as they took back unwanted clothes or fitting room tags.

The experiment was carried out for 2 hours between 3pm and 5pm during which 62% of customers walked back to the installation space to view their silhouettes. They typically reacted positively and looked around the space to see how it worked. The fitting room staff member would typically then demonstrate how cast shadows were captured when the projection went white. Customers would then often step forward to cast a shadow, typically engaging in a short subtle interaction, for example, by waving their hands.

**DISCUSSION**
The ten studies aimed to understand the relative contribution of space and place to engagement with a public display by installing Shadow Wall in quite different physical and social contexts. As noted by other authors [2, 5, 15], there are boundaries of both perception and participation to overcome when trying to engage users with a situated display. While the spatial properties of the area around the display were seen to be important in determining whether people in the vicinity would notice it, the core finding, comparing across the different studies, was that place trumps space with regards to participation: a conducive social context could overcome a poor physical space and encourage interaction; conversely, an inappropriate social context could inhibit interaction in spaces that might normally facilitate engagement. This section discusses themes that emerged from the qualitative analysis and that we put forward as sensitising concepts that might be used in the design or analysis of situated displays in different social and spatial contexts.

**Space and Salience**
The reasons that people notice and glance at large displays depend on many factors [11]. However, placing the display in a salient position based on paths of natural movement through the space and in terms of maximizing the area from which the display is visible was effective in attracting attention. We found concepts from the architectural theory of Space Syntax to be useful in thinking about spatial structure around the display, although formal calculations were not carried out (cf. [4, 9, 21]). In particular, the concept of an *isovist* – the area from which a point in space is visible – was useful in thinking about the placement of the display. For example, during the Outdoor Screening Event, more people noticed the display when entering into the space than when exiting from it.

However, salience within a space was not sufficient to communicate the interactivity of the display. As the Dance Studio and Open Day studies showed, even when a person noticed Shadow Wall they were still often unaware of its interactive capabilities (cf. [17]). Several ways to communicate a display’s interactivity have been described in existing work (e.g., [2, 16]).

We also found that spatial visibility could discourage interaction. As seen in the Open Day study, the salience of the projector beam combined with a lack of awareness of the display’s interactivity created a negative space, which passers-by purposely avoided.

**Visibility of Incidental Interactions**
Müller *et al.* [17] observed that passers-by often notice interactivity just as they leave the interaction space, and have to walk back to interact (the ‘landing effect’). Chained displays have shown to be effective in this situation [15, 22]. However, in the case of Shadow Wall, because of the 8-second recording window, the effect was not usually seen until the passer-by had left the interaction space. Therefore, this kind of incidental interaction was not always enough; the installation required other people to wait or gather in the space nearby or to follow behind.

If a group of people, rather than an individual, walked through the interaction space, then incidental interaction tended to be more effective in attracting attention to the display as one person often noticed the interactivity and signalled to the others. Similarly, if the space was occupied by people either sitting or standing near to the display – as in the WET Event, Campus Café or Skate Park Breakout Area studies, for example – then the incidental interactions of those walking through the space were likely to be seen and discussed by this audience. As O’Hara *et al.* [19] suggest, the exploration of interaction in public by means of trial and error can be awkward, especially when the manip-
ulation requires physical and expressive movements, as is often the case in playful interaction. This can create a reluctance to initiate interaction. The incidental interactions help understanding through social learning. Passive observation allows a spectator to see possible manipulations and their effects, reducing the need for trial and error exploration and allowing time to understand the mechanisms and decide whether to participate.

However, once more the social context of the display largely determined whether this greater awareness of the interactivity would lead audience members to cross the boundary into interacting themselves. In the relaxed breakout area in the skate park, audience members were frequently seen to have a go with Shadow Wall after watching others walk past. In the busier campus café, where interaction involved leaving comfortable sofas, and the more socially uncomfortable WET event however, this was rarely the case.

Different perceptions of place
Once a media façade or wall display has caught the attention of passers-by or onlookers and communicated its interactivity, it must encourage initial interaction [17]. People were seen to be naturally curious about Shadow Wall, looking at and discussing the installation. However, it was the individual’s evaluation of the ‘place’ that determined whether or not they would actively engage in subtle or direct interaction. Place attaches social meaning to a space; people enact social norms through their activity. If the place was unfamiliar or uncomfortable, then it could inhibit interaction (e.g. for the students at the WET event and amateurs at the Dance Studio).

Place, however, as a social construct is not experienced uniformly by all of the people in the same location. Familiarity with a location and confidence in the situation were seen to reduce social apprehension. Thus, in the Dance Studio the professional dancers and staff were much more comfortable interacting with Shadow Wall and this inhibited interaction by the amateurs who were intimidated by their expertise. Similarly, the staff members running the WET event engaged enthusiastically with Shadow Wall, whereas the students did not. Onlookers in the Summer Party reacted differently to the activity of the emergent champion: some joined in immediately, while others waited until the champion moved away before plucking up the courage to have a go.

Emergent champions and comperes
Similar to previous work [19], our studies have shown that the activity of comperes can help create a social buzz around a display, removing many of the social inhibitors that prevent people from engaging in interaction and making the interaction socially acceptable. It is socially easier to engage in collaborative interaction, so spectators who are motivated, were more likely to respond to the social cues to join in.

We also highlight here the important role played by emergent champions who played a similar role to comperes in explaining the system to others and encouraging participation, but who weren’t explicitly given this role and weren’t part of the project team. Emergent champions were instrumental in encouraging interaction with the system, most notably in the Summer Party and Dance School studies. Furthermore, the Clothes Store studies showed that some of the negative effects of a poor space (lack of visibility or throughput) could be ameliorated through the activity of champions and comperes. However, not all of the effects of emergent champions were positive: prolonged interaction during the Summer Party study meant that those unwilling to join in with the social interaction were not given the opportunity to become performers themselves, and some people seemed to be put off by eager champions, waiting until they had left before interacting. Furthermore, the relationship between the emergent champion and the onlooker proved to be important, with the eager participation of the professional dancers in the Dance School study proving to be a barrier to interaction for the amateurs.

CONCLUSIONS
Previous work has highlighted the importance of aspects of both the physical (e.g., visibility [5]) and social context (e.g. the effects of being watched by an audience [19]) in facilitating engagement with situated displays. However, as they have typically been studied in a single location, it has not been possible to determine whether engagement is primarily due to the space or place. By installing the same installation in multiple locations that differ in spatial properties and social contexts we have been able to explore this question. The main outcome is in agreement with Harrison and Dourish’s claim that “[s]pace is the opportunity; place is the understood reality” [8, pg. 67]: while spatial factors had a significant effect on people’s understanding of the interactivity of the installation, their understanding of the place had more influence on whether they actually interacted with it. For example, at the WET event, the connectedness of the space meant that several people walked through the interaction space, triggering incidental interactions, and the high visibility of the location meant that it was viewed by a large number of people. However, the slightly uncomfortable social context meant that almost no students intentionally interacted with Shadow Wall. Conversely, it was possible to work around the effects of a space that inhibited interaction, such as the confined and out of the way location used for the Clothes Shop study, through the enthusiastic participation of the staff members who created a playful social context or through the direct use of comperes to draw the attention of passers-by to their own incidental interactions [cf. 19].

The most successful places in terms of engaging users in interaction were the ones where the social context provided a ‘licence to play’, such as the skate park, where Shadow Wall was appropriated as a means to show off and as an aid to perfecting tricks. The Summer Party provided an envi-
environment where interaction was facilitated by both the space — it was in a visible location with a high footfall — and the place — it was a fun social event (and no doubt helped in this regard by the alcohol available). Consequently, people lingered in this location for some time and an enthusiastic champion emerged.

Given the relative importance of place in relationship to space outlined in this paper, the main implication is that more attention should be paid to understanding the different ways in which participants perceive the social context in which an interactive display will be placed. The social context of a challenging space can be manipulated to encourage engagement, for example, by using comperes, but it is difficult to work against existing social constraints, irrespective of the facilitation of spatial factors. A broader conception of design may be necessary when positioning displays in public, where more attention is paid to influencing the surrounding social interactions to create a conducive place.

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