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NETWORKED ARCHITECTURAL INTERFACES:

Exploring the effect of spatial configuration on urban screen placement

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ABSTRACT

This paper explores the placement of an exemplar digitally connected urban screen, installed in the real world. It describes on-going work of implementation and evaluation of networked interactive screens in Urban Space. Our approach is inherently cross-disciplinary bringing together methods from Architecture, and Interaction Design to integrate placement, local interactivity and distributed connectivity of four screen nodes connecting Nottingham with London.

In this paper, we focus on one of our sites in London. Our analysis draws upon the spatial methods used to detect target positions for the screen placement. It is motivated by the assumption that visual and spatial configurations might raise potentials for human interaction with digital screens. We then reflect on how actual pedestrian activity measured by systematic observation techniques corresponds to the spatial measures and may support our assumptions before and after the screen implementation.

The methodological tasks were designed to understand how spatial and visual properties of the targeted layouts correspond to the social usability, co-presence and movement activity. This understanding would enable a more sensible judgment over what makes the ideal location for a touch screen in the urban setting.

We suggest that the properties of the spatial configuration may play an important role in influencing the nature of the interactions with the screens. However, we highlight in particular the dynamic and interconnected nature of this mediation, defined through the spatial layout, people, type of social activities, and time of the day.

Keywords: *Urban Screens, Research in the wild, Spatial and Social Configuration, Mediated Interactions, Shared Encounters.*

Theme: *Architectural Design and Practice*

INTRODUCTION

Large digital and interactive screens are becoming increasingly part of our cities. Digital urban screens are already used for advertising, global newsfeeds, art, and local information, as well as for entertainment, sporting and cultural events [Fatah gen. Schieck, A., 2005; McQuire, S., 2008]. Mostly, however, experiences with public media screens are characterized by display blindness [Muller, J. et al, 2009]. Most of the time people look briefly or even ignore the display completely [Huang, e. et al, 2008]. In this regard, understanding aspects around the implementation for this technology and its impact on place and the quality of public experience is important. Increasingly, media screens are becoming interactive allowing people to communicate with the screen content. More recently they are becoming networked allowing two-way remote communications mediated through the screens [Fatah gen. Schieck, A. and Shaojun F. 2012; Fatah gen. Schieck, A. et al 2012; North, S. et al, 2013].

This raises many questions about how the public will experience both the urban space and the mediated urban interactions enabled through this infrastructure.

An important feature of interaction spaces generated through the presence of digital public displays, is that they are defined both by the properties of the architectural setting and the space in which the displays are placed, along with the properties of the displays [O'Neill, E. et al. 2006]. For example, within a public place, different social interaction spaces are created depending on the various architectural areas identified within the layout [Hillier, B. and Hanson, J., 1984]. The urban display would then create an additional public interaction space, which, together with the type of social activities that the architectural layout supports, may influence the passers-by role in different ways [Fatah gen. Schieck, A. et al, 2008; 2010; Behrens, M. and Fatah gen. Schieck, A., 2013; Behrens, M. et al, 2013].

As part of our effort to explore the potential of networked urban displays for communities and culture, we outlined the need to consider more clearly the social, spatial and temporal aspects of urban space to successfully implement public display interfaces [Fatah gen. Schieck, A. et al, 2012]. Overall, our approach is driven through research-by-design, including the design, implementation, and reflective evaluation, which in turn feed back into the design cycle (figure 1).

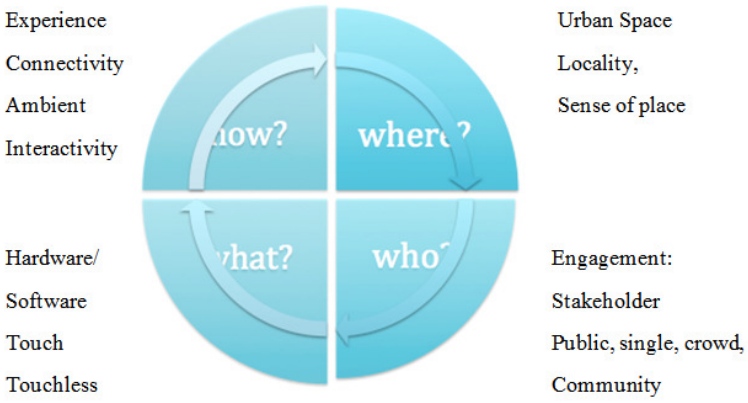

Figure 1: The methodology applied is based on action research and iterative design process.

In this respect, we designed and deployed four networked urban screens: two in East London and two in Nottingham, UK. The screen hardware consists of a TV sized public display (46"), which is fitted with a touch foil, speakers, a web camera and an IP night vision camera. The

format of the screen is portrait to enable full body interactions. The foil is attached to a display window and the screen and hardware sits in a case behind the shop front.

As general support for interaction and potentially also as a standalone experience, synchronous four-way video communication (no audio) was implemented. The video panels, generating the video feed at each of the nodes, have been placed at a low height as set of four video panes, towards the bottom of the screen to encourage interaction from and with children. The Video link encourages synchronous multi-user interaction across the four screen nodes by providing a view of who is interacting and a way to acknowledge or even interact with the other party by waving and through gestures [North, S. et al, 2013].

In this paper, we focus on the spatial properties (through site analysis and observations) and explore how this may influence the decision on screen placement within the urban space. We address:

1) Site analysis and site selection and how this influences the screen placement.

2) How the architectural layout may support different interaction zones that influence the nature of the mediated interactions (physically, socially, and technologically).

3) Social behavior such as social learning and the change of roles from passers-by to spectators and actors.

We discuss the role of the architectural layouts in framing the interactions, and the types of social activities and the emerging interaction zones they may support over time.

In the next section, we review related work. In particular, we focus on projects that have embedded explored technologically mediated interactions urban situations. In section 3, we outline our methodology, and highlight the spatial analysis we carried out in one of the screen sites in Leytonstone (East London). We describe the observations and evaluation outcome before the implementation of the digital prototype, and the observations and evaluations outcome after the deployment. In section 4, we discuss preliminary findings. Specifically, we discuss these findings with regard to spatial relationships and stress in particular the dynamic nature of these configurations and highlight the role of place within the urban space. Finally, we draw conclusions on certain aspects and outline our ongoing work.

BACKGROUND RESEARCH

While it is well understood that architectural built environment and its spatial configuration give rise to movement and encounter patterns, creating a platform for rich and diverse social encounters [Hillier and Hanson, 1984], there is little understanding, however, of how movement and shared encounters are influenced by the advent of location-based media technologies [Fatah gen. Schieck et al, 2010].

Extensive research has been carried out to explore the challenges of deploying public screens in urban space. Behavior related to the social effect of people attracted to the public display through the presence of other people close to it was identified, along with the 'transition zones' between the phases of interactions in [Bringnull and Rogers, 2003; Vogel and Balakrishnan, 2004]. On the urban scale the role of space, social proximity and full body performative interactions in shared spaces [Fatah gen Schieck et al, 2008; O'Hara et al, 2008; Peltonen et al, 2008] or in remotely connected spaces [Fatah gen Schieck and Shaojun, 2012] have been addressed. Ways to attract passers-by to public displays and what is required to notice

interactivity in urban space have been explored in detail [Muller et al, 2012; Michelis and Muller, 2011]. Through introducing 'urban HCI' the spatial aspects of urban media installations have been described [Fischer and Hornecker, 2012; Fischer and Hornecker, 2011]. Brynskov et al contributed to the understanding of flexible social interactions by addressing urban interaction - in relation to distributed attention, shared focus, dialogue and collective action - calling for a need to take into account multiple viewing and action positions [Brynskov et al, 2009]. The contextual characteristics of media architecture were addressed, including parameters that impact on its integration into the existing social fabric from a socio-demographic (*environment*), technical (*content*) and architectural (*carrier*) perspective [VandeMoere and Wouters, 2012].

The background research presented above has not addressed in details a number of highly significant challenges in urban screens design and implementation. There has been too little consideration of large digital screens as a facet of urban design, of the methodological challenges of deployed systems and of the challenges related to medium or long-term implementation. Nor has it addressed the different theorizations on the nature of urban space, place making [Gehl and Gemzoe, 1996; Carmona et al, 2003] and their relationship to pedestrian movement and their potential impact on the design of public displays and the nature of the emergent interaction, which may be supported through them.

Our previous research has contributed considerably to the understanding of situated interactions and shared encounters mediated through large urban screen acting as a stage for social interactions and performative play in a city context. Our findings demonstrate the importance of taking into account full body and performative interactions as an essential factor of human experience [Fatah gen. Schieck et al, 2010]. We observed clear differences in the intensity of interactions with the technology and with other people mediated through this technology in different locations in the city. This seems to be determined, to some extent, by the spatial configuration of the city. More significantly, we noted that city rhythms [Lefebvre, 2004] – the way that variations in pace and density are structured over time –play a key role in shaping the type and intensity of interactions mediated through media technologies [Fatah gen. Schieck et al, 2008].

In this paper we describe our approach as part of our on-going research [Fatah gen. Schieck et al, 2012]. Our approach is inherently cross-disciplinary bringing together methods from Architecture, Computer Science and Interaction Design using iterative design process and working in 'action research' mode engaging research organisations with the end user communities and the primary project partner. In the next section, we describe our methodology in details.

METHODOLOGY

The methodological tasks were designed to understand the configurational properties of the urban environment and how spatial and visual properties of the targeted layouts correspond to the social usability, co-presence and movement activity.

This is achieved using Space Syntax methods for: (i) empirical observation using both quantitative and qualitative methods (ii) spatial analysis of the urban space in terms of visibility and accessibility; (iii) social mapping of the groups and existing social practices, focusing on the social construction in London Borough of Waltham Forest and the social experience of the City (in this paper we focus on Leytonstone). The results of the observations were used to inform the selection of a range of screen placements. We then continued to explore the effect the screen placement had by observing behaviour before and after the screens implementation. The spatialisation of behaviours in relation to the screen placement was analysed using

ethnographic and space syntax methods.

This understanding would enable a more sensible judgment over what makes the ideal location for a touch screen in the urban setting.

Methods before screen implementation

Spatial Analysis

Different spatial analysis methods[1] were devised in this study to predict movement and occupation potentials (and to enable a comparison between predicted movement counts against observed movement counts on site). Most of the methods used are based on the principles of visual and accessibility affordances in a two dimensional layout [Turner, 2001]. They are based on the background theory of Space Syntax that presents a synchronic representation of the built environment based on its visibility and permeability [Hillier & Hanson, 1984], which indicate potential movement and social behaviour in space.

Results

The analytical investigation is pursued with the purpose to highlight potentials for certain areas to accommodate interaction between humans and screens given their spatial and visual affordances. Some spaces will be seen as to offer better visual properties that enable a higher exposure for screens to pedestrians than others. At this stage, we ignore attractors such as land uses or train stations and we only consider the plain visual configurations of the environment. We also ignore the fact that a screen in the public space might both attract and occlude vision and we only consider the values of visual configurations as to offer a range of probabilities for human/screen interaction.

The *visual integration* maps demonstrate potentials for occupational functions in a layout and where more social activity is likely to be (figure 2). Higher values are marked with red. In Leytonstone, some areas of interest where people are likely to stop and occupy spaces are located in front of the underground station, at the crossing near the church, and at the crossing linking the café to the pub. Areas of interest where people are likely to move towards by means of configurations are mainly along the high street, particularly at the crossing near the church where the screen is currently located. Whether this means that this particular location is the most ideal location for the screen is questionable. This is mainly due to the fact that the strategic and visual characteristics of this location qualifies it for being target for excessive commercial uses that might invest in its street facades adding to that traffic signs and dense movement. The flux of visual information might overwhelm pedestrians' perception to an extent that they no longer notice the screen. For this reason, it is difficult to assume simply that a maximised visual exposure for the screen might necessarily mean more interaction. We need to acknowledge the presence of other actors in reaction to the visual affordances of the environment.

[1] Spatial analysis is produced using open source UCL Depthmap software V10, originally written by Alasdair Turner

Figure 2: VGA Integration measures were rendered on the base maps[2] of Leytonstone.

Observations

This part addresses the description of field observations on pedestrian flow and static activities in the urban environment. For this purpose, consistent and well-structured observations on-site were designed to measure real movement and occupational behaviour and to test the spatial predictions. In the sections that follow, we will explain the observation methods and how these observations were conducted on site with special regards to the particularities of the project and how the observations serve in allocating target areas for the screens.

Gate Counts

Gate counts were directed to observe the density of pedestrian movement flow throughout the whole urban structures. To conduct the observations we chose a number of locations that cover the urban areas under study. We covered a range of well-used, moderately-used and poorly-used spaces in and around the boundaries of the target area. We then chose a reasonable number of 'gate' positions, around 20 gates. We observed each gate for 5 minutes over four time intervals during a working day and a weekend. Some gates were divided into three due to the dense movement flow that goes through them. Categories were noted as accurately as possible. The focus was on age categories given the assumptions that some age categories are more likely to interact with touch screen media than others. We mostly focused on marking children, adult women and men, and older women and men.

Static snapshots

Normally, static snapshots are conducted to record the use pattern of spaces within buildings. In our case, we regard certain parts of the urban environment as areas where potential occupational activity might take place, reflecting on Gehl and Gemzoe [1996] definition for what makes urban place. For this reason, we apply this method to the observation of public squares and spaces in the three target locations. The method is useful for comparing static activities (standing, sitting) and movement. By tracking and mapping these activities in time we may outline the patterns of space use in an area and spot the locations where more potential interaction takes place naturally in the studied areas. In general, snapshots might be comparable to a photograph taken from above showing one moment of activities and mapped onto the floor plan. They are usually taken at consistent intervals during the day, to provide an objective view of the invariant patterns of activity as well as different and peculiar behaviour throughout the day.

[2]Basemap source: © Crown Copyright/database right 2011. An Ordnance Survey/EDINA supplied >service

To conduct snapshots we have predefined easily observable areas and positions at which an observer could maximise visual exposure to the observed field of study and at the same time minimise his/her own visibility to the users. We have noted activities (sitting, standing, moving, interacting) for a period of five minutes over four time intervals during the day.

Leytonstone

Area covered by observer

Locations where Snapshots and area-based movement traces are to be taken

/6 Locations for gate count observations with numbers of gates associated

Figure 3: Allocation of gates and areas for snapshots and movement traces on each site.

Movement traces

Movement traces were used in conjunction with the snapshot method wherever there was possibility to do so (*i. e.* no dense traffic across the target area). It enabled tracking and mapping the collective flow dynamics through a predefined area and where people are likely to enter/exit the area from. This also means that we were able to outline islands where no movement traffic was recorded for potentially positioning the screens. Additionally, it was devised to allocate spots at which the visual exposure by passers is maximised. Similar to snapshots, target areas were defined prior to the observation task and the area was observed at similar time intervals as the snapshots.

Results

In this section, we will be highlighting the main outcomes of the observations conducted on site to empirically track and map human behaviour. These observations are directed to test the spatial models we have derived earlier from the visual configurations of the urban layouts. Where there is a correspondence between both observation and space exists, it comes as to validate and support our assumptions on the role of spatial visibility and access in promoting certain spaces to be more hostile for human/screen interaction. Where there is less correspondence, further investigation is needed to define any external attractors or outliers in the environment. We will first reflect on the overall pedestrian flow across the layouts. In a

second reflection, we will focus on the higher resolution movement activity for different age groups, highlighting the fluctuations of movement flow for these categories during working days, weekends and both.

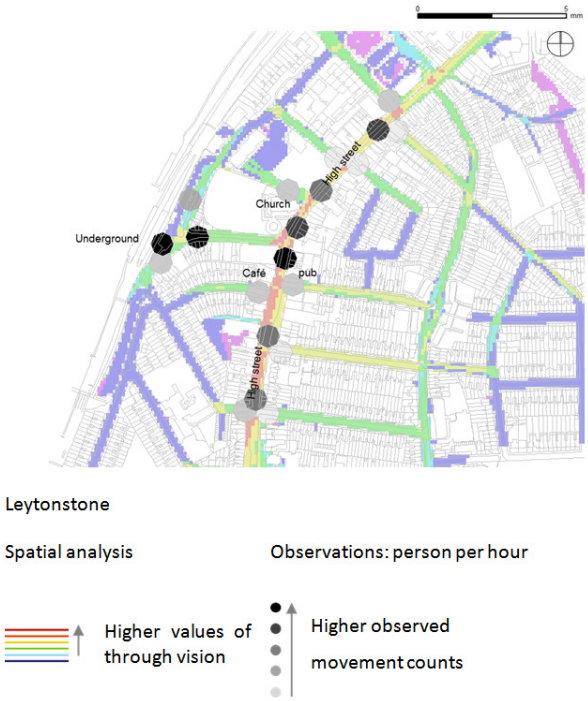

Figure 4: Gate counts for observed pedestrian movement during weekdays overlaid on top of *through vision* analysis in Leytonstone

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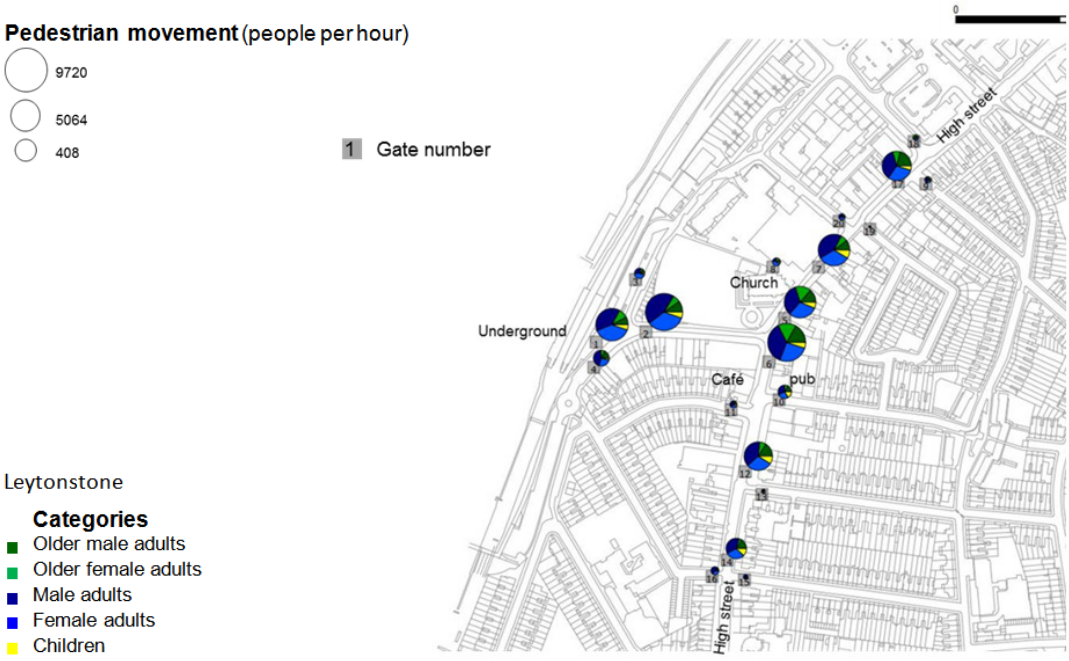

Figure 5a: Observed pedestrian gate counts for different age and gender categories during weekdays.

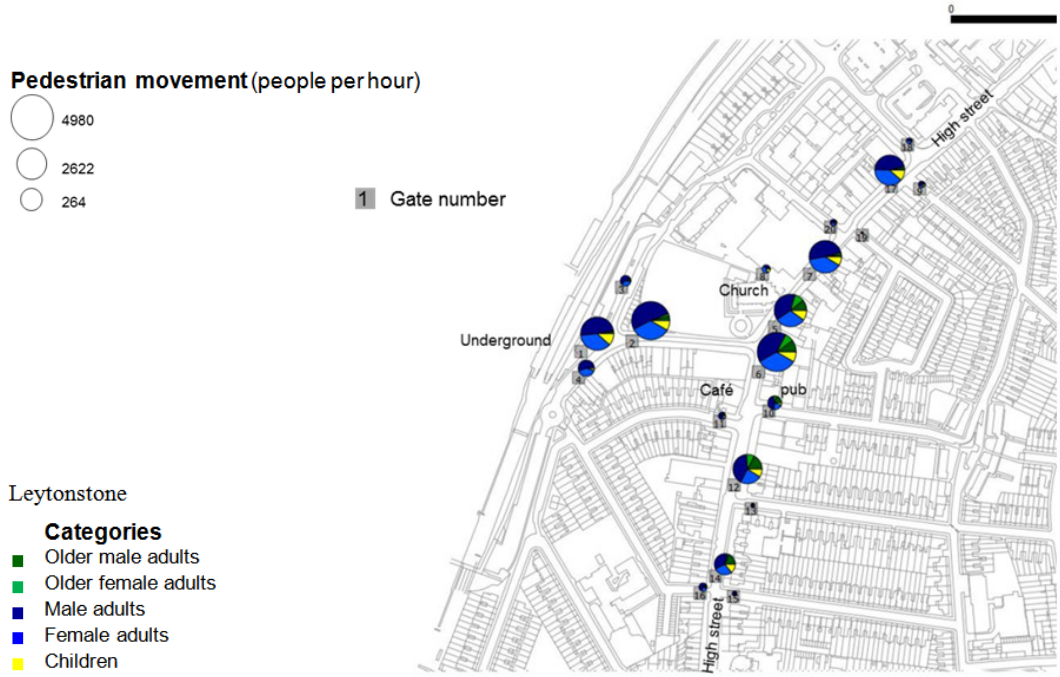

Figure 5b: Observed pedestrian gate counts for different age and gender categories during weekends

Based on the analysis we discussed above we identified a few suitable locations to place the screens (figure 6). The final site selection was based on practical factors such as the availability of the site, the possibility of the deployment, and other factors related to the interest of venue owners and businesses in the area (the details are beyond the scope of this paper).

Figure 6: One screen node in Leytonstone, London. above: Possible screen locations. below: final screen location.

Methods after screen implementation

The observations after the implementation of the screens are better defined as 'experience' or studies of people's behaviour towards the screen. The purpose of this study was to identify patterns and frequency of behaviours, which occur in relation to the screen node but also any random and unexpected behaviour. We started with an initial list of behaviours that it is common to be tracked and tested in relevant screen studies. Through the actual practice of doing we refined the method, apart from resulting to interesting findings on how people relate to the screens. The initial categories of observed behaviours were:

- Pass (not pay attention to the screen)
- Glance at the screen
- Stare at the screen (change body orientation)
- Slowing down to look at the screen while walking by
- Stopping to look at the screen while walking by
- Pointing or gesturing towards the screen
- Discussing screen content with others
- Direct interactions (brief)*
- Direct interactions (long)

*brief interactions refer just to a couple of touch

One weekday was chosen for observations in each focus area. As for the time period of observations, again a 12 hour period was covered, split in 4 distinct periods as: morning, lunch peak, early afternoon and late afternoon (9am-9pm). However, one time slot was observed per period. In this case, we had a full hour of observations per time slot aiming to more accurate results.

We refer to visual interactions when people glance or stare at the screen, including head and body orientation, slow down and/or stop to see the screen and its content (Huang, E., 2008) We refer to physical interactions when people touch the screen, whether this is a brief or long engagement. To summarise, we were interested in people who pay attention to the screen, involving glance or more bodily involvement and physical interactions, but also the ones who didn't notice the screen, always in reference to the overall number of people who pass-by/cross in front of the screen and within the defined for observations purposes interaction zone. In this respect we considered as people who glance all visual and physical interactions, including glance, head orientation, body orientation, brief and long engagement (glance, stare, touch). Based on the overall count per time period we found that about the same percentages through different time periods through the day (with the exclusion of the morning session which was incomplete) notice the screen. This is around 11-15 % of the overall count which is relatively low but quite significant (figure 7).

During 17.00-18.00 pm we had the highest number of people crossing the observed area but also the highest number of people interacting with the screen. However, the highest percentage of engagement took place during 20.00-21.00pm when we had the lowest flow.

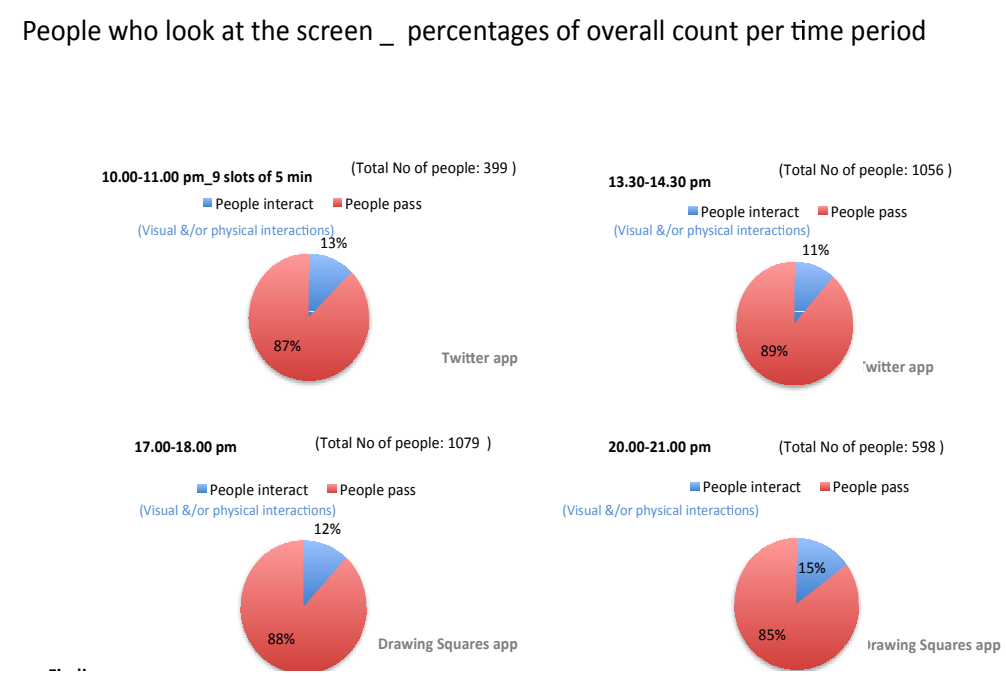

Figure 7: Comparison between number of people who pass in front of the screen without looking (red) and the ones who interact: glance or touch (blue). People who interact: this category includes all visual and physical interactions_ glance, head orientation, body orientation, brief and long engagement (glance, stare, touch).

Time period	No. of Visual Interactions (glance)	No. of Physical Interactions (touch)
Morning_ experimental slots_9 slots of 5 min each_ 10-11 am	50	0
Lunch peak_13.30-14.30 pm	120	1
Afternoon peak_ 17.00-18.00 pm	127	1
Late Afternoon_ 20.00-21.00 pm	82	7

Table 1: Screen behavior: Visual and physical interactions:

Visual interactions: people glance or stare at the screen, including head and body orientation, slow down and/or stop to see. Physical interactions: touch the screen & brief or long engagement (touch).

What we found is that more interactions stay to the glance level. A limited number of touch (physical) interactions took place and most of them were during the last time slot, at 20.00-21.00 pm.

Focusing on the categories of behavior, we found that whenever people notice the screen, they mostly glance or stare. This is the most dominant category for all time slots of observations. Moreover, the highest percentages of engagement is during 20.00-21.00 pm. This is also the most diverse in terms of behaviours towards the screen. All the categories are represented during this last time period that we observed.

Identified Interaction Zones

We also observed the location during an event; one researcher was present in Leytonstone between 3pm and 6pm. His tasks were observing interactions, image and video capturing as well as supervising the system.

Through the observations we were able to identify different zones, 1) more suitable for direct interactions mediated by the networked urban display, and 2) interactions not related to the display and zones, which are transient (pavement). In each of the identified zones people may change their role from actors to spectators or passers-by whilst entering a different zone [Behrens et al, 2013].

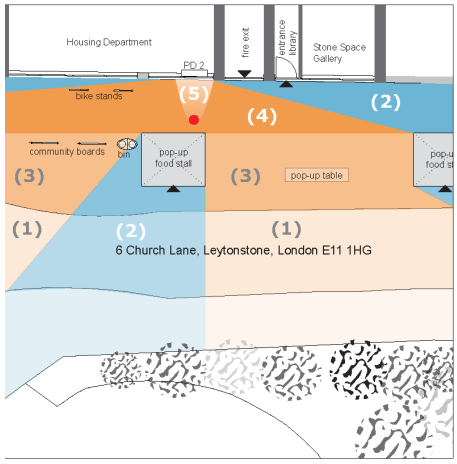

Figure 8: Interaction zones at Leytonstone Library with stalls during an event (1,3,4,5) visual access to screen, (2) zones without visual access to screen, (3) spectator zone with, (4) direct interactions zone including transit zone, (5) position for full-body display interaction.

Direct interaction space (zone 1)

During the event the direct interaction space and the surrounding public space partially overlapped due to the dense spatial layout (distance between the surrounding objects ie the stalls and screen ca. 2.5m). Occasionally passers-by even felt upset by actors (mostly children) who used all the space in front of the screen to interact with the people on the other side.

Figure 9a: Social behavior and technology mediated interactions (1) interacting children collide with a passer-by (2) attract attention - brief encounters and change of role from passer-by to spectator with a temporal 'honey pot effect' (3,4,5) dense passage with actors, spectators and passers-by over time.

Figure 9b: Mediated remote interactions with attempts to communicate: (1) gesturing (2) touch interactions (3) watching (4) writing on paper.

Surrounding public space (zone 2)

This zone is ambiguous. This was framed through the given spatial layout during the event (with stalls), the fact that the pavement in front of the display was occupied by a food stall, and the view onto the screen was partially blocked. Spectators as well as passers-by had difficulties to find their position to perform.

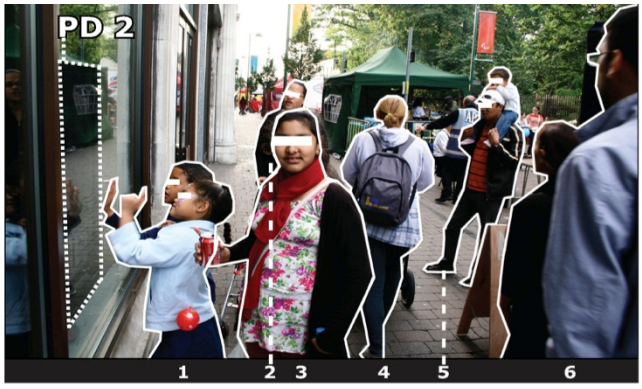

Figure 10: Simultaneous interactions - ambiguous zone (1) two children interacting with digital display (2) young woman recognizing the presence of the researcher (3) mother watching her kids interacting with display (4,6) passers-by, (5) father with child looking at the display from distance.

In summary, our observations demonstrated that the networked displays encouraged successfully participation among friend, acquaintances and strangers. Spectators and actors engaged in performing interactions and expressing desires to perform and interact in novel ways. Situating the networked digital media in the urban space, and encouraging embodied and playful use of technology, offered a stage for rich types of performative interactions that reinforced the diversity of shared experiences in the physical places. The nature of these interactions and their appropriateness are tied to the properties of the spatial layout in addition to the affordances provided by the technology.

CONCLUSION

In this paper, we presented findings of social interactions and related spatial configurations as part of our ongoing project 'in the wild'. In our investigation, we moved from predictive spatial models that highlight areas for potentially high interaction to observations that confirmed our predictions both before and after the screens implementation. We used different visibility analysis techniques to outline the spatial configurations of the built environment on the global scale. We also used systematic observations on the global scale of the urban neighborhood and the local scale that is adjacent to the screen to outline patterns of human/situated digital media interaction in space and time, something we recognized as the influence of digital technology on the daily rhythm of urban life.

The findings suggested by the spatial analysis and observation indicate to a clear relationship between high visibility –as configured in Space Syntax- and the daily influx of pedestrian movement. Not a very striking finding in itself, since much of Space Syntax studies agree on this correspondence. What is even more interesting is the outlined increase in interaction and engagement with the digital displays that corresponds to dense pedestrian movement at peak time hours. Above and beyond that, it is the position of the screen in the urban layout that determines the degree of interaction more than the actual timing of the activity. This finding is highlighted through recognizing higher engagement at a time when slower pedestrian movement is taking place. Another explanation for that might be related to the effect of crowd and how the collective pace of movement might make it less likely for individuals to slow down and use the screen, or might occlude vision and distract focus. The localized interaction zones are also suggestive of some relationship between a maximized interaction and the visual properties of the immediate environment where the screen is embedded. The zones seem to be spatially distributed within an isovist visibility field starting from the screen and spreading towards the surrounding environment. While an accessible surface appears to be a priority condition for interaction, the street furniture seems to have an occluding effect on the visibility

of the screen.

In the background of our observations, we recognized the complexity of the urban scene. We clearly identified simultaneous multi layered behavior along with different types of interactions (direct, wide and connected) in a given spatial setting. These differ in relation to the interaction zones and also in relation to the different interactions mediated through the public digital display. The observed spatial configurations revealed a dynamic interplay of people and their changing roles when moving across different interaction zones. We observed site specific interactions which are related to the spatial layout and the display context as well as generic behaviour which appeared on both screen locations.

Overall, we have identified clear differences between adults' response and children's response to the display presence. People appropriated the medium and performed embodied interactions in diverse contexts. The interaction process in many cases consisted of a number of phases, with transitions in between starting with one action followed by a direct and sometimes personal interaction and then followed by another related or unrelated display activity. In particular, children moved in and out of the direct interaction zones many times over the course of the event creating place-specific rhythms.

We argue that the generated urban experience is strongly related to the characteristics of the architectural space and its affordances, the people use these spaces, the social context and the type of activities that take place in addition to the properties of the media installation itself. We suggest that the properties of the spatial and visual configurations on the global scale and within the local setting play an important role in influencing the nature of the interactions with the screens. We also highlight the dynamic and interconnected nature of this mediation, defined through the spatial layout, people, type of social activities, and time of the day.

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