What Chalk and Tape Can Tell Us: Lessons Learnt for Next Generation Urban Displays

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ABSTRACT
In recent years, many researchers have explored the different roles public displays can play in the urban environment. A particular focus has been on the deployment of digital screens. A range of technical, spatial and social factors have been found to influence the appeal, acceptance and usage of such screens. As there are still a range of unsolved issues around digital screens, including display blindness and evaluation apprehension, we argue that when thinking about the design of next generation urban displays, it is important to not only focus on these digital screens. Instead, we propose also investigating other types of displays, including non-digital ones. We contribute to this evaluation of a wider range of public displays by presenting two case studies in which non-digital public visualisations of local data were deployed in urban communities. Based on the findings from these studies, we distinguish four affordances of non-digital public displays and describe the opportunities these reveal for the design of future urban displays.

Categories and Subject Descriptors
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

General Terms
Design, Human Factors.

Keywords
Public displays, digital screens, urban communities, engagement, case studies, urban informatics, design opportunities.

1. INTRODUCTION
The deployment of digital screens in the urban environment has become increasingly popular in recent years. Case studies conducted by various researchers have shown that while digital screens have great potential for informing and engaging, there is still a range of socio-technical challenges left unsolved. One is attracting the attention of passers-by and overcoming ‘display blindness’ [12, 16]. Another is getting them to interact with the content shown on displays proves to be a challenge too [3, 7]. O’Hara et al. [17, p. 71] describe this phenomenon as ‘evaluation apprehension’, where people experience “a fear of being judged for their behaviour by social others in the vicinity witnessing the behaviour’.

As a result, digital screens can remain underused or even unused. Seeing as the installation and maintenance of urban screens are often costly, there is a big interest in findings ways to overcome these challenges. To this end, a number of in-the-wild studies have been conducted to reveal best practices and design implications for urban screens (e.g. [4, 11]). However, while such studies have described a range of improvements that can be made to the design and deployment of digital screens, the main challenge of visibility remains.

But what if the affordances of digital screens are simply not suited to informing and/or engaging passers-by in urban communities? While public screens fulfil an important role in the public environment, such as at airports and stations, their role in community settings may be less effective. Here people use screens for a specific purpose – to find out when their train or plane is leaving, what platform or gate it is going from and when boarding starts. Advertising and news updates may be displayed alongside them on an adjacent screen as secondary material. For public displays designed for other purposes, such as engaging members of a community to participate, vote or create it is less clear what type of displays are effective. Despite numerous attempts to design screens to fit into urban settings, findings from a number of in the wild studies show them being used infrequently or not in the way hoped for [7]. While other types of displays are different from digital screens in what they can present, how they are updated and interacted with, we show that evaluations of their design, deployment and usage can reveal valuable design opportunities for future urban displays. Moreover, we argue that when considering urban screen interventions it is useful to consider a mixed low-tech high-tech approach, where a combination of technologies and materials are used both to inform and create the final design. In order to understand when, what and which physical and digital technologies to use it is important to consider the affordances of both.

In this paper, we begin by summarising related work in the area of physical ‘non-digital’ displays, followed by an overview of two case studies we conducted that investigated
the role of non-digital public visualisations in combination with the use of digital devices to collect urban and personal data from community members. Using the findings from the related work and our case studies, we then outline a series of affordances of non-digital displays – together with a set of design implications these have for the development of next generation urban displays.

2. RELATED WORK

In order to inform the design of future urban displays, we propose investigating the lessons that can be learnt from non-digital displays. A number of researchers have previously looked into the lessons that can be learnt from various types of non-digital displays, including public noticeboards and public visualisations of local data. Various researchers have studied existing public noticeboards and bulletin boards, with the goal of finding out more about how these are used, and how this use could be supported by digital screens. Early fieldwork by Churchill et al. [8] aimed to uncover where in the urban environment such boards are typically placed, what types of content is posted on them, and how communities perceive and make use of these boards. Later work by Taylor et al. [22, 23] specifically looked into the benefits such public noticeboards have over their digital counterparts, including their ease of use, affordability and durability. The visual persistence identified as an affordance of whiteboards in office spaces by Tang and Fels [21] was seen as a disadvantage in community settings, as content quickly grows old. Implications for the design of digital noticeboards were later formulated by Alt et al. [5], based on an in-depth evaluation of existing paper-based notice areas located in different European cities. These implications relate mainly to the accessibility, freedom for locals in adapting the screens according to their needs, and support for the takeaway of information.

A few researchers have explored alternative form and materials for projecting displays in public settings. In particular, three deployments of non-digital public information displays stand out: Neighbourhood Scoreboards [15], Tidy Street [6, 10] and Street Infographics [9]. *The Neighbourhood Scoreboards* created by Vande Moere et al. [15] were aimed at motivating participating households in a neighbourhood in Sydney (Australia) to reduce their energy usage. By revealing private information public, the researchers intended to encourage peer pressure and competition within the area. As such, the use of private displays, public and private displays and no displays was compared in a between-subjects experiment. The public display consisted of polypropylene sheet, mounted to the facade of the participating households. Using pens, various rankings and graphs were manually written and drawn onto these displays, including a historical graph, a comparison of the performance of that household with the performance of the day before, and the daily ranking when compared to others in the neighbourhood. Using a mixed methods evaluation, the researchers established that the project had acted as a point of conversation in the neighbourhood, created awareness of energy usage and successfully managed to change the behaviour of a number of households (average decrease in energy usage of 2.5%).

The aim of the *Tidy Street* project [6, 10] also was to motivate residents of a street in Brighton (UK) to reduce their energy consumption, but using the nudging technique of a social norm as the basis for the underlying street visualisation. Over a period of three weeks, participating households were asked to submit their daily electricity meter readings via a website. This data was then used to give households feedback on how their usage compared to the average usage in Brighton and other regions in the United Kingdom. In addition, the data from all participating households was aggregated and transformed into a large public visualisation on the road of the street. The line graph was displayed onto the street using chalk graffiti, and allowed residents and passers-by to compare the energy usage of the street with the average usage in Brighton. The project managed to reduce the household's average energy use by 15% and created discourse in the community as well as attracting attention from passers-by and media.

*The Street Infographics* created by Claes et al. [9] were placed on four street corners, below the existing official street signs. With the aim of engaging the local neighbourhood (four streets in Leuven, Belgium), the Street Infographics publicly display data on the demographics of the area. Specifically, the percentage of people with Belgian nationality versus non-Belgian nationality in the street was displayed, together with the percentage of students versus non-students. The design of the street signs was informed by the design principles set out by Vande Moere and Hill [14]. The Street Infographics managed to attract attention from local residents and successfully conveyed information about the demographics of the street to them, according to the findings from pre and post study interviews conducted by the researchers. Furthermore, the authors describe how they observed that the signs created discussion between residents.

While these studies show that the use of public non-digital displays for communicating urban data has been subject of investigation, reflection on the implications their findings can have on the design, development and deployment of future urban displays has yet to take place. In the following section we describe two additional case studies we conducted that explored the affordances of public non-digital displays, and their ability to attract public interest in terms of local discussions and increased awareness. We then make an initial attempt at reflecting on the affordances of non-digital displays and the design implications and opportunities these reveal for next generation urban displays.

3. CASE STUDIES

Below, we present the design rationale, main findings and reflections on the efficacy of two case studies where street displays have been specifically designed for the local community to inform them about the community’s opinions, perceptions and aspects of the local environment. Underlying both is the use of ‘home-made’ public non-digital information displays, intended to engage a community in reflecting on and discussing local data. We conducted both case studies in Cambridge (UK).

3.1 Visualising Mill Road

Mill Road (Cambridge, UK) historically consists of two demographics, as half of the street was built by colleges of Cambridge University in order to house university staff, while the other half of the street was built to house railway work-
ers. While the street has changed drastically during the last few decades, its history remains a significant part of everyday life. As a result, Mill Road has a small scale ‘urban divide’, with many residents preferring not to cross the railway bridge that connects the two parts of the street. From our initial conversations with residents it emerged the area built for railway workers (Romsey) is perceived to be less safe and less socially connected than the other half (Petersfield). Romsey’s residents are very aware of this stereotype and tend to strongly disagree with it – with some claiming the opposite is true.

The objective of our study was to provoke discussion and reflection on different topics relating to the Mill Road community (happiness, neighbourliness, safety, community, local shopping, street buzz, localism, and future), by allowing people to learn more about the opinions held within the community – with the aim of challenging these existing perceptions. Therefore, we developed dedicated physical voting devices (see Figure 1) to gather opinions on different topics from Mill Road residents and visitors. Topics were defined by and with members of local community groups and included safety, neighbourliness and the future of Mill Road. The devices offered three voting options: ‘happy’ (yellow button), ‘neutral’ (white button) and ‘sad’ (blue button). To communicate the data gathered via the voting devices, a pictogram-like public visualisation was designed. This visualisation consisted of a column of keywords summarising each topic. Next to each of these keywords, a row of ten little figures was shown, representing 100% of the votes. Depending on the percentage of each type of votes (happy, neutral and sad), these figures were filled in with different colours – corresponding to the colours of the voting buttons (see Figure 1).

Furthermore, a bubble graph summary visualisation was designed, in which the aggregated results from both areas of the street were compared. Inspired by the work conducted in the Tidy Street project [6, 10], the visualisations were displayed on Mill Road’s pavement using non-permanent chalk graffiti. The visualisations were applied using laser cut polyester stencils. The voting devices were deployed for three weeks, in 18 shops on Mill Road. During this period, all voting data was publicly displayed outside the participating shops – allowing people to walk from one shop to the next to compare the results. The visualisations were updated every other day by four local artists, who were paid 10 pounds per session. The summary visualisation was sprayed onto the railway bridge after the initial seven questions had been posed to the community. During the in-the-wild study, shopkeepers acted as informants – sharing their observations and conversations with the researchers. From their feedback and our own observations and interviews, we were able to conclude that the visualisations managed to attract a large amount of attention from local residents, visitors and media. It also emerged that people actively compared the visualisations between shops and areas. Many people also regularly returned to see the updated information. Furthermore, the addressed topics acted as talking points, resulting in people sharing anecdotes and opinions. The results shown in the summary visualisation surprised many, as the area often stereotyped as being less safe and less connected scored more positively for all topics.

3.2 Fair Numbers

Following the Visualising Mill Road project, members of the community and community groups asked the researchers to do an additional study during the annual fair held on Mill Road. This project, called Fair Numbers, further investigated the use of a non-digital information display to communicate local data during the course of one day. Our aim was to provoke visitor’s perceptions of the annual fair, by showing them a comparison of objective and subjective data of the event. As the intention was to engage a large variety of people, two topics of relevance to all visitors of the fair were selected: noisiness and crowdedness. During festivals and fairs, noise and crowds often have positive associations, while similar noisiness and crowdedness in a different setting could be perceived as a nuisance. As everyone perceives these two phenomena differently, we chose to publicly show objective data combined with the data on how the visitors rated them.

Using Smart Citizen sensors [1], a custom tablet application and photos, subjective and objective data on these two topics were gathered. To communicate and compare the data gathered via the sensors, tablets and photos, a minimalist hour-by-hour comparison visualisation was designed. For
both sound and crowdedness a three level icon was used, representing low, medium and high measurements (see Figure 2). The sound icon was an adaptation of the well-known speaker icon, while the crowdedness icon used dots to represent people (where more dots means more people). Inspired by the phenomenon of ‘tape art’ (e.g. [2]), the street art theme of Visualising Mill Road was continued when selecting materials for this second study. The visualisation was created by attaching neon tape and neon Christmas baubles to a black plastic sheet which functioned as canvas. During the annual fair, we made use of the railway bridge in the middle of Mill Road for the deployment of the visualisation. Along the road, sound sensors were attached to street lights. A team of researchers was also spread out over the length of the road, asking passers-by to indicate via the tablet app how noisy and crowded they thought that specific location was. The data collected via the sensors, tablets and photos taken of different areas of the road were then transformed into a comparison visualisation. The visualisation was updated approximately every hour and readjusted regularly based on the gathered data. Throughout the day, passers-by noticed and discussed the visualisation — though many needed additional explanations from the researchers in order to fully understand what was shown. A number of people interacted with the visualisation by touching the tape and baubles, and some expressed they expected it to respond to such interactions in some way.

4. AFFORDANCES AND IMPLICATIONS

From our case studies it emerged that non-digital information displays have a range of affordances. Below, we describe four of these affordances in-depth, together with the design implications they have for next-generation urban displays.

4.1 Positioning

While an increasing number of digital screens are deployed in the urban environment, engaging passers-by with them has proven to be a major challenge. If public displays do not successfully attract attention, they can remain unused. On the contrary, once a display does attract some attention, this attention can rapidly grow due to the honeypot effect [7]. As such, research has focused on existing practices and uncovering why people do not notice or want to look at screens (e.g. [7, 12, 16]). Apart from factors like the screen size, social context [3] and the expectations people have of the shown content [16], an important determinant of whether a digital screen is noticed is where and how the display is positioned [12]. While certain adjustments can be made to the positioning of screens, including placing them at eye-height, current digital screens still have a number of constraints that are harder to overcome. For example: digital screens require a certain infrastructure (e.g. electricity and Internet connection) and they need to be integrated into the urban environment somehow (for example in standalone frames (e.g. [18]) or as part of a building’s facade (e.g. [19])). To overcome some of these limitations, several studies have focused on creating displays by projecting data onto surfaces in the urban environment using digital projectors (e.g. [24]). This approach is particularly popular with urban artists (e.g. [19, 20]). While such projections remove some of the constraints relating to the positioning of the displays, another limitation is added: projected displays are only highly visible in the dark. For outdoor urban displays, this means the information is only available during the nighttime.

Non-digital displays are far less restricted in where they can be positioned, as they have fewer constraints. For example, they generally do not need to be connected to any type of infrastructure (e.g., they do not require electricity). As a result, all surfaces in the urban environment become available as potential (temporary) displays, assuming permission is sought. This allows for custom displays, made to fit into the environment. The Visualising Mill Road case study has revealed how moving away from upright, vertical urban surfaces (like walls and windows), to the horizontal, flat surface of the pavement and street can successfully attract attention all the way along the street. Moreover, it encourages people to walk over the chalk, which provides an embodied experience of what is being represented that is quite different from looking up at a display. On Mill Road, literally positioning the displays on the doorstep of the local shops ensured passers-by and customers noticed the visualisations and were able to connect the data with the location. Shop-keepers, who played the role of informants during the study, said that “People are absolutely fascinated by the visualisations outside — and they stop, look at it and then look up into our shop”, “It is very eye-catching. It has caused quite a bit of interest, people saying ‘What is that about?’” and “There is always someone out there explaining [the displayed data] to someone else”. These findings suggest more emphasis should be put on the design and deployment of public displays that make use of a wider range of surfaces. Whereas the focus is currently on upright screens, the investigations on Tidy Street and Visualising Mill Road have shown the potential of flat, horizontal displays for engaging urban communities. Seeing as people often look down while walking, to avoid uneven surfaces, waste or dirt, displaying information in this manner can attract attention in a natural way.

Design implication: Exploit alternative display surfaces. While current public digital screens are still primarily positioned upright, initial investigations of non-digital information displays reveal flat, horizontal displays, positioned on the street or pavement, can successfully attract attention as...
people generally look ahead at the surface they are about
to walk on. Seeing as existing upright digital screens often
struggle with visibility, due to people’s ‘display blindness’
[16], exploring the usage of different display surfaces could
help tackle this issue.

4.2 Delayed updates
The lack of live updates is a major difference between digi-
tal and non-digital displays. However, the findings of the
Visualising Mill Road and Fair Numbers studies show delays
can be a powerful method to engage people – as it allows for
the content to slowly unfold over time. All displays in the
Visualising Mill Road study were updated every other day.
By arranging regular and fixed moments during which such
updates take place, communities can gain awareness of the
pace in which they can expect additional information. Dis-
play updated become anticipated events. This anticipation
can motivate people to return to the display, knowing more
information will have been added. During the Visualising
Mill Road study it became apparent members of the com-
munity quickly understood the updating rhythm, and as a
result started returning at the appropriate moments. For ex-
ample, shopkeepers mentioned people started visiting their
shops just to vote and view the updates. To see if and how
such a delayed updating process can also work during the
course of a day, we updated the Fair Numbers display once per hour. As this updating process was obvious from the de-
sign of the visualisation (as it is basically a timeline), people
understood the rhythm of the updating process and made
plans accordingly (e.g. “I will come back later today”, “So if
we come back later, we can see how it has changed through-
out the day”). Further research is required to establish how
long such delayed updates can motivate urban communities
to stay engaged, and how delays can match existing com-
munity rhythms. However, our initial exploration suggests
that by slowly unfolding the data, engagement can be sus-
tained. One reason for the success of such delayed updates
may be that the updates fit in better with the pace of the
community: as people may not visit public and streets every
day, occasional updates can attempt to match this rhythm.
If there is a need for live updates, phones, tablets and com-
puters in people’s personal environment can provide instant
access to such content. Our findings suggest that public dis-
plays can engage communities in a very different manner by
making content updates into anticipated events.

Design implication: Reconsider the necessity of live data.
While current technology enables the presentation of real-
time data, our findings show that delayed updates (whether
once an hour or once every two days) can in fact have a valu-
able role in engaging urban communities. By updating at
regular, fixed moments, anticipation can be created within
communities, encouraging people to return to the display
knowing new content will have become available.

4.3 Tangibility
For the display used in the Fair Numbers, we made use of
two alternative visualisation materials: neon tape and neon
Christmas baubles. These materials were chosen because
they were colourful, lightweight and easy to attach to the
canvas in various shapes. During the in-the-wild deploy-
ment it became apparent these materials had another af-
fordance: they attracted people to the visualisation. The
tape’s and baubles’ textures and shapes appeared to have a
natural appeal, motivating people to approach the visuali-
sation in order to touch them. During the fair, we observed
two types of tangible interactions: firstly, those who touched
the visualisation merely because they were attracted to the
textures and shapes. This group consisted primarily of kids,
for whom the displayed data was generally not of interest;
they just wanted to play. A number of people (both adults
and kids) in this category expressed disappointment when
they discovered there were no interactive components, with
one passer-by asking “What does this do?”. Secondly, those
who touched the visualisation while interpreting or talking
about the data. This group consisted primarily of adults.
It appeared these people did not expect any response from
the objects they touched, instead they used the tangibility
of the visualisations as an aid while thinking about the vi-
sualisation. As neither the Visualising Mill Road nor any
of the other case studies described in the related work sec-
tion have made use of materials with alternative textures
and shapes, further investigation into the appeal of these
materials in a public setting is required. However, our ini-
tial work suggests tangible elements can motivate people to
approach urban displays to explore what is shown from up
close.

Design implication: Integrate tangible elements to stim-
ulate engagement. The findings from our initial exploration
of more tangible public displays show that the textures and
shapes materials like tape and baubles offer can attract passers-
by.

4.4 Transience
Many of the digital screens deployed in public spaces are
designed to be robust and easy to update with different
applications, as they are often placed into the urban en-
vironment for lengthy periods of time (see for example [18]).
Non-digital displays, however, generally do not possess these
same qualities. Depending on the materials used, non-digital
displays are likely to (quickly) deteriorate and updates are
significantly harder if not impossible to implement. De-
spite these limitations, the findings from the Visualising Mill
Road study show the transient nature of non-digital displays
can have benefits too. The chalk graffiti used for this display
communicated this temporary nature clearly, as it slowly
fades with rain. Therefore, passers-by and shopkeepers were
aware of the fact that the displays would disappear within
weeks. Months after the deployment of the Visualising Mill
Road study, a regular visitor of Mill Road reflected “it being
so temporary made it feel even more special, I found myself
going to Mill Road more often”.

Design implication: Design displays with a finite lifetime
As the materials of non-digital displays often implicitly re-
veal for how long the display will stay, community members
can adjust their expectations accordingly (for example, by
visiting the display more frequently during this period). Fur-
thermore, the transient nature of non-digital displays pre-
vents content from growing old, and allows for the develop-
ment of custom displays.

5. DISCUSSION
Current thinking around future urban displays is often fo-
cused on the potential of existing digital screen technology,
and how such technology can be used in combination with mobile devices. This thinking can be constrained by the affordances of these specific technologies, rather than a response to the needs of urban communities. As such, we argue it is important to consider the affordances of a greater variety of displays when thinking about future technology, including non-digital displays. Depending on the objective of the display, non-digital displays can be more effective in engaging communities—and the four affordances described in this paper are key to this. Our work provides an initial analysis of affordances of non-digital displays and the implications these have for future urban displays. We have focused on four main affordances that emerged from our two case studies, though more affordances exist—including affordability, the eco-friendliness of the materials and visibility from all angles and in all weather conditions. While further investigations are required into lessons that can be learnt from non-digital displays, our findings reveal how a number of affordances of non-digital displays can successfully engage people in the urban environment.

6. CONCLUSION

Numerous studies have looked into the deployment of digital screens in the urban environment, as a means of informing and/or engaging people. However, such digital screens have proven to have a few (till date) unsolved challenges, that can limit their usage. While in-the-wild studies of digital screens can inform the design of future urban displays, we argue the study of non-digital display can also reveal valuable design implications for next generation displays. In this paper, we have described three case studies investigating the use of non-digital public displays to engage people in urban communities. Based on these studies, we presented four affordances of non-digital displays, namely the positioning, tangibility and transience of the displays, together with how it allows for the unfolding of content. For each affordance, we set out the corresponding design implication for the design and deployment of future urban displays.

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8. REFERENCES