"You Are Here" - Experiences with Located Symbols

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Abstract. This paper describes experiences with an application in which users read barcoded signs with camera phones to obtain content about their surroundings at seaside locations. The application was made available to the general public in support of "Coast", a BBC television series about the UK coastline. The paper highlights lessons from that trial in terms of what worked well and what was subject to deployment constraints. In particular, it describes how several factors affected the users' engagement with the signs, the places, and other users: the barcode and mobile phone technologies; semantic issues such as signs' relationships to landmarks; and practical issues such as local regulations.

1 Introduction

Linking physical places to content and services is a well-established paradigm in ubiquitous computing, but a poorly understood one. While several technical mechanisms have been proposed for achieving it, there is little understanding of their interactive properties with respect to locations, content and other people. An important factor that has held us back in our understanding is a lack of real-world experience. Typically, research projects do not have the means for a large-scale deployment, especially where the equipment cannot be easily replicated.

This paper seeks to remedy that lack, through experiences with a public deployment of an application for content delivery at seaside locations in support of "Coast", a BBC television series. This trial is part of the Active Print project [1], which is investigating technology near to ubiquitous availability: users read 2D barcodes with camera phones. Each of about 100 signs around the UK coastline bears a unique barcode. By pointing the camera of their phone at a barcoded sign encountered while out walking, users get BBC content (images, text and audio) about where they are.

Reading 2D barcodes with mobile imaging devices has existed as a laboratory-based activity for some time, e.g. [11]. Reading them with camera phones is now becoming established with the Japanese public, but even though the technology

raises many questions, we have not found systematic investigations into users' experiences,. The application for the BBC is meant to enhance a familiar activity, namely encountering places and things of potential interest while out and about, by providing associated content or services. But does it in fact provide value to users? Are there pitfalls – perhaps destructive interleaving effects between use of the technology and other behaviours? How does it affect social engagement between the members of a party? Similarly, little is known about how to design for this paradigm. What is good and bad about the design of the interaction itself, and the content delivered through it?

This paper contributes insights based on real-world experience that help answer those questions, into both the opportunities arising from embedding 2D barcodes in public places, and the practical limits to doing so. We have developed novel aspects of the application and performed an in-depth study of it in its context of use; we also looked at the interaction from the point of view of the content developers. We describe the different types of relationship that a barcode can have to its location, and the role of the barcoded signs and mobile phone technology in social interactions. An important finding is that the apparent precision of a barcode's location is to some extent masked by practical constraints. In principle, the location (& orientation) of a barcoded sign on a particular lamp-post can be known to a far greater accuracy than GPS could provide, and ought to be a suitable basis for delivery of highly location-specific content. But we will show that that advantage cannot always be realised.

Symbols such as barcodes have applications that go beyond the support of an individual TV series. They may become embedded in our lives to a far greater extent than seaside signs – e.g., on individual posters all over our cities, and items in newspapers. Given the negligible expense of printing symbols and, most importantly, the increasing penetration of camera phones, symbol-reading is potentially the first truly ubiquitous computing mechanism beyond satellite positioning by which widespread applications will merge the physical and the digital.

2 Related Work

In this section we discuss several mechanisms that have been suggested for linking physical places (and things) to content, looking at what little is known about the implications of their choice for real-world deployment or user behaviour.

A number of projects have used 2D barcodes as a means of attaching information to places. The Semapedia project [13] is attaching barcodes to things and places which link to wikipedia pages about them. In the Marunouchi "Ubiquitous Museum" in Tokyo, visitors can obtain location-specific information on their mobile phones via barcoded signs placed in public places [10]. However, neither project has reported on the practical concerns of embedding codes in the environment, or how this placement determines the relationship between the content and place. Yet, as the Cooltown project [9] highlighted, ambiguity may arise in the placement of these codes, in terms of what the information refers to. For example, does a barcode placed on the wall of a meeting room refer to the "web presence" of the room or the

"web presence" of something in the room, such as content being projected on the wall nearby? Rukzio et al. [12] captured some initial requirements in relation to this type of technology by looking at user behaviour at existing urban poster sites. They used this to discuss use of posters as gateways to mobile services; they have not, however, explored user behaviour and the practical concerns associated with a real deployment of such a system.

RFID [5, 14] and Bluetooth or infrared beacons [9] are alternative technologies for attaching content to objects and places which involve the installation of *devices* rather than symbols. They have been considered mainly from a technical perspective; the way these tags and beacons reference place, and the impact of their technical properties on interaction and social behaviour, remains under-explored. These technologies are similar to barcodes in sometimes presenting ambiguous references to objects or places. Another factor receiving little attention from projects exploring these technologies is "visibility". RFID tags and beacons can be difficult to spot. From an aesthetic perspective this may be regarded as an advantage, but it is not clear how (in)visibility affects interaction around location-based content and services. How is the user to know whether there is a tag or beacon pointing to content in a particular place – or what part of a larger space is referred to by the content they have picked up from it? We explore this factor further in this paper, in particular the less obvious ways in which visibility relates to social interaction around location-based content.

GPS as a triggering technology for location-based content has received considerably more attention: researchers have investigated how it can be used in various models of interaction, and how content triggered by it relates to location. Most notable are the recent efforts of the Equator and Mobile Bristol projects (e.g. [4, 8]), where GPS sensors in mobile clients link content and services to places defined as coordinate points and regions. These projects have conducted substantial user research into the behavioural consequences of GPS-based interactions, including those arising from inherent inaccuracies and uncertainties of GPS positioning. That research helps us understand how best to use GPS for location-based experiences, and guidelines have been created for accommodating these inaccuracies as part of the experience. Like RFID tags and beacons, (in)visibility is an issue for GPS: users are not by default aware which places are electronically augmented and which aren't. GPS also has the interesting property that it requires no deliberate act on the part of the user to access content. Barcodes, by contrast, require a deliberate act to engage with location-based content. This deliberate engagement is a factor that we want to consider as an explicit concern through our observations in this paper.

Finally, the impact of location-based technologies on social interaction is starting to receive more attention in the literature. This is exemplified by the studies of Sotto Voce [2], which highlighted how audio content on PDAs became a resource for facilitating the social and conversational aspects of a location-based visitor experience. Different triggering technologies, mobile clients (e.g. mobile phones) and content will have interestingly different impacts on the social experience of location-based services. In the current paper we aim to articulate how these social experiences are shaped by 2D barcode triggers and mobile camera phones.

3 The Active Print project

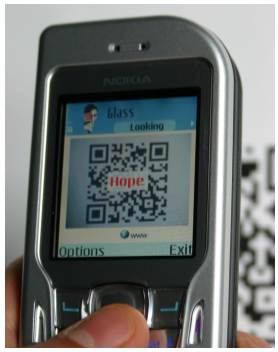

Fig. 1. Reading a QR code with a camera phone

The Active Print project [1] is exploring how printed materials (and digital displays) can be linked to online content, services and applications in many types of situations. The project focuses on how this can be done using the mobile phone – the device that many people carry with them everywhere. Current camera phones have good enough optics, resolution and processing power to be able to read 2D barcodes (which we call "codes") on the printed materials (Fig. 1). Since camera phones are coming to predominate, this method is widely applicable. We have constructed Glass, a code reader application for Series 60 camera phones. A key component of Glass is Gavitec AG's Lavasphere [6], which performs the steps necessary to read data from codes of the QR and data matrix symbologies. That software captures video or still images from the phone's camera. It then performs image processing to detect code symbols and extract their data, applying error correction as necessary. Detection and recognition occurs in real time at video rate by default.

We use codes to encode (1) descriptive "pop-up" text and (2) service-invocation information such as URLs and phone numbers. Glass extracts the pop-up text and displays it to the user as soon as the code is read (typically at video rate), with no need for network access. This is an opportunity to tell the user more about what the code links to. The pop-up text scrolls across the screen and persists when the user takes the phone away from the printed matter so that he or she can better consider the two together. If the user decides to click to "activate" the code (akin to clicking on a link in a web page), Glass initiates one of several types of service access. In particular it can:

- initiate a Web (WAP or HTTP) download
- send an SMS message to a service.

The principal advantage of code-reading over conventional ways of accessing services on mobile phones is its convenience. It saves typing on the keypad and, in the case of WAP content, many frustrating delays caused by waiting for menu pages to load onto the small screen. A code "deep-links" directly to the content or application indicated by the printed matter, which can present different codes for different options.

In this paper, we are particularly interested in codes on "situated" print: that is, printed matter distributed to well-defined locations or mobile situations. That includes posters and signs, in such places as bus stops, stores, tourist sites and public transport vehicles; it also includes direct mail (where a personalised letter is sent to a particular postal address), and leaflets such as newspaper inserts delivered to particular streets. Individual "copies" of an artifact can be printed and distributed bearing

unique codes containing location-specific data (URL paths or SMS keywords). The location-specificity of the codes enables providers to deliver a location-specific result, to trace a service access to a location, or both.

While we recognize that many service accesses are best done “in the moment”, it is also true that some users will be too busy and will want to access a service later. Glass therefore saves codes as entries on a “history” screen for later access. Moreover, a saved entry can be turned back into a code on the phone’s screen so that another user can read the code and transfer it directly onto their phone without having to use Bluetooth (with delays due to discovery).

4 The “Coast” trial

The “Coast” trial consists of twelve structured walks at coastal locations around Britain to accompany the BBC Coast documentary series [3]. Each walk consists of at least 8 walk points at which there is a BBC sign from which content can be accessed via the mobile phones of the users – the general public (see figure 2). The signs were attached to lamp posts, railings, tourist information boards, and, occasionally, the inside of a window.

(a) (b)

Fig. 2. Examples of the walk point signs

The content from these signs can be accessed in several ways:

1. On each sign is a data matrix code in the bottom right hand corner. When these codes are read by the phone the pop-up text confirms which particular walk point it is (for example, Cardiff walk point 3 or Glasgow walk point 1). Activating the code links to WAP content relevant to the particular location including facts, pictures and anecdotes as well as embedded links to the audio guide (see #2).
2. On the sign is a phone number to allow users to listen to audio content – short stories, facts and dramas about where they are standing, as well as directions to

help find the next walk point. The audio clip at each point is no longer than 90 seconds.
3. Users may also obtain an index page of all locations by sending a text message to a number specified on the sign, and receiving a "WAP push" message in response.

The point of the first method is that, once the code has been recognized, just one click – and no browser navigation – is required to obtain location-specific multimedia content. The other methods enable users without the code reader to experience content.

At the end of each piece of content, users are given directions to the next point. In the case of the audio content, directions are spoken over the phone and then followed up with an SMS message containing directions. For the WAP content, a link to text-based directions appears at the end of the WAP page. Within the WAP pages, there is a link to "all walk points" from which it is possible to access the content and directions for any walk point regardless of whether the person has found or read the previous walk point. So finding a particular walk point was not completely dependent on finding its immediately previous walk point (or, indeed, the previous sign).

At the time of writing, after the first-run transmission of the TV series has ended, the Coast "mobile experience" continues to be accessible to the general public. The "BBC Code Reader" (an adaptation of Glass) is downloadable over the air, using instructions on the BBC's web site [3]. Nineteen users (10 male and 9 female, aged between 18 and 44) were recruited specifically for the trial for in-depth research. These users did a walk in one of four of the BBC's selected coastal locations: Cardiff, Plymouth, Glasgow and Whitby. We collected data through observations of people doing the walk and through *in situ* and follow-up interviews.

In this section we present findings from the trial, drawing on our observations, interviews and data from questionnaires. We use the findings to illustrate key issues relating to the meaning of location and highlight key characteristics of this mobile phone barcode technology in the delivery of location-based content and experiences. The findings are organised into three main themes: engagement with the signs, engagement with the place, and engagement with others. The theme of mobility recurs across those topics. Of particular note is how the mobile phone application allows a user to choose where and when to experience content obtained from a walk point sign.

4.1 Engaging with the Signs

We begin with a discussion of user engagement with the walk point signs. We first discuss how signs relate to the area in which they are embedded, as a function of how they are positioned and mounted within that region. Second, we discuss how the signs' positioning affected users' experience of reading the codes on them.

The Catchment Area of Signs

An important feature of the code technology is the need to have something visible in the environment, in this case the signs mounted on lamp-posts and railings. This visibility has important outcomes, some of which contribute strongly to the location-based experience and some of which present practical difficulties.

The presence of signs themselves is the first indicator that there is something of interest about this particular location. While there are certain tourist attractions and heritage sites for which this "interesting" label is obvious, there were many features of environments on the walks for which this interest would not have been obvious. Were it not for the salience of the signs, much of these features would remain hidden or users would not have realised they were interesting. This salience of the signs (and codes) is particularly important in the context of using mobile phones as the reader technology. The mobile phone, unlike its PDA counterpart, is ubiquitously carried by people in their everyday lives; it is always available when such a sign is encountered.

Yet while the visibility of the signs played this important role in denoting points of interest, in practice there were also times when users experienced difficulties finding certain signs. Sometimes this difficulty was turned into fun in the form of a "treasure hunt". But sometimes it caused considerable frustration:

"I couldn't find the first one. The actual plaques you are looking for are about 6 inches. I was expecting a big poster or board – couldn't find it – and asked several shop keepers – they didn't know –I spent about 45 minutes looking. Normally I would have sacked it about half an hour."

Despite having maps of the walk points as well as directions from the audio and video content, there were several examples in the observations where users would walk straight past particular signs and even stand directly underneath a sign without being aware of it. So while salience is a positive feature, achieving it in widespread urban environments was not always easy. In understanding this we discuss practical issues around the design, positioning and deployment of these signs for real-world use.

On the face of it, one might simply assume that the signs were too small and not distinctive enough to be noticeable.

"That's not very clear – they are so small you can really easily miss them – they should be bigger or more colourful or something to attract you to them."

However, it would be simplistic to simply say that the signs should be bigger. The size of the signs cannot be considered in isolation - what matters is the sign size relative to the potential area where one is looking. This is highlighted by the fact that some signs associated with the larger landmarks were particularly difficult to find. The larger landmarks themselves are easy to find but because these sites are large and can be seen from a larger distance, they have a much larger *catchment*

area: the region where one could position a sign that is likely to be understood to reference the landmark. For example, with buildings such as the Norwegian Church, the Pierhead Building in Cardiff or Finneston Crane, a large industrial crane in Glasgow, there were particular difficulties in findings the signs.

"You have the Norwegian church and all the space round – it could have been anywhere around that building."

This is seen in Figure 3 which shows the area around Finneston Crane and the actual positioning of the sign. The sign is positioned some way away from the crane with a large expanse of car park space between the sign and the crane. We observed users looking all around the car park for this sign, unable to locate it.

Fig. 3. Walk point sign next to Finneston Crane in Glasgow.

Compare this to signs associated with smaller landmarks, such as the statue in Fig 4, which has a much smaller catchment area. This smaller catchment area allows more precision to be given in the directions, making signs easier to find.

Fig. 4. Signs next to statue in Cardiff Bay

Understanding the nature of the catchment areas around these landmarks is complex and not simply about the size of the area. There are often particular architectural features that help define to people what the semantics of the space are around a particular landmark. In the Finneston Crane example, the barrier around the car park was seen as the architectural feature that bounded the area around the crane. Therefore it made sense for people to search within this area for the associated sign post. The problem with the Finneston Crane sign was that, despite being within meaningful distance of the crane, for practical reasons it was positioned outside this understood architectural boundary of the space, damaging its spatial association with the landmark. Likewise, for practical reasons the sign for the Pierhead building in Cardiff was positioned on the Boardwalk on a level below the immediate space surrounding the building. This not only makes it more difficult to find the sign, but also suggests that the sign is associated with something completely different – a real challenge for designing experiences of this kind.

"If I saw that I would think it was for the boats – I wouldn't think it was for the building. Because it is by there [notice board next to ferries] – it should be up there [by the actual building]."

The signs could have been designed to bear a picture or description of what they denoted, instead of being almost identical but that would not, of course, help find them.

In addition, certain parts of the space surrounding a particular landmark were also understood by users to be more appropriate for sign positioning. With buildings, for example, some users' instinct was to look initially in the area surrounding the entrance. When such expectations were matched, the signs were very easy to find. When such expectations were breached, confusion was caused. For example, in Glasgow there was a ship called the Glenlee which had a visitor centre next to it. People's expectations were that the walk point sign would be somewhere around the entrance to the visitor centre whereas it was actually positioned way beyond this area in a point chosen to gain a good view of the ship, to meet the demands of the narrative.

Fig. 5. Sign in Plymouth mounted facing away from approach direction

Signs need to be carefully oriented. Signs can help orient the user towards the point of interest, as in the case of the Glenlee. But a sign's orientation may also affect users' ability to find it from a particular approach. Ideally, signs would be visible from all expected approaches, since users were not expected always to follow the signs in the order of the directions. However, in Fig. 5, for example, the walk directs users to approach this sign from the road leading off to the left of the picture, causing difficulties for one user:

"As we were approaching where the sign was [near the citadel] on the lampposts it was on the wrong way – we didn't actually see it until we had walked past. I turned round and went back to find it."

Practical Issues

When considering these difficulties, numerous possibilities seem to be available to improve design and placement of the walk point signs to make them more noticeable and easier to find. However, by doing a real-world, long-lasting installation of this application as opposed to a temporary research/prototype based installation (operating in a more idealised design space), the issue of sign placement became compounded by various legal and practical factors. Because the signs were made of metal and to be in place for twelve months, they were subject to planning laws that affected what signs could be placed where and for how long. Moreover, these laws varied from place to place. In some places regulations pertaining to temporary signs differed from those for permanent signs; whether the signs were to be considered temporary required discussion with local authorities.

These laws become an important part of the design space for this kind of location-based application. They had an effect in several ways. First, size of the signs was partially chosen as a compromise between what information needed to be displayed

and planning laws – larger signs were subject to even stricter rules that would have complicated matters further.

Signs also had to be attached to something existing such as a sign post or railings. Such signposts might not be ideally positioned to avoid some of the problems outlined earlier. Under such circumstances, it was necessary to go for the closest fit. Thus, while this code-based location-sensitive technology in theory affords precise control over location, this was compromised by the need to attach them to less precisely positioned fixtures.

With certain heritage sites, of which there was a significant proportion on these walks, there was particular sensitivity to the placement of signage by the planning department since they need to consider the aesthetic and cultural integrity of these places. Some of the seemingly "poor" positioning of the walk point sign posts arose because permission was not granted to place signs on certain fixtures within the immediate vicinity of the sites. For example, permission was not granted to place signs on the more semantically appropriate choice of railings immediately surrounding the Pierhead building in Cardiff. As such the sign could only be positioned somewhere that was semantically disparate from the actual building.

Further difficulties arose simply from the logistics of actually deploying the signs to their appropriate places. It was a requirement, for example, to use a council-approved contractor to put signs on public signposts and lamp posts. Making such intermediaries aware not just about the correct lamppost or railing but also the precise orientation for successful discovery was a logistical headache.

Interacting with Signs

Once the walk point signs were found, the subjects were then able to engage with the signage at another level. The visual nature of the technology again played an important role here. The sign was not there just to carry the code but also presents relevant information. In this case, the sign displayed information about the source of the content (BBC logo) and the potential financial costs incurred by downloading content. Such information played an important role for users who regarded it as necessary for deciding whether they would engage with such content. In this respect, location-based triggers to content and services cannot be regarded as something that exists meaningfully in isolation in the environment. Information is sometimes necessary to explain their presence. With symbol-based technologies such as 2D codes which need to be visibly displayed, the ability to display additional contextual information comes for free (in contrast to some other location-based technologies such as RFID or Bluetooth where the provision of such information becomes an add-on).

The ability to make decisions about engagement with the location-based content was embodied in the technology itself. The optical characteristics of the phones require that users stand close to the signs to effectively position their camera phones to read the codes. This had to be a deliberate act on the part the user. While there are many virtues of automatic location-based triggers for certain applications, the deliberate nature of this particular technology had several positive effects here. First,

it gave users control over whether to engage with the location-based content or not. Second, it gave users control over the timing of the engagement. That is, they could choose *when* to trigger the content. Location-based triggering technologies can often confound the notions of space and time on the assumption that people have chosen to be in a place at a particular time. Yet when it comes down to managing some of the everyday mundane practicalities of the situation, fine-grained control over timing can become an important part of a successful experience. For example, it allowed people to take time to "manage" their children before initiating an interaction, or simply to have a leisurely look round their environment before engaging.

In terms of reading the codes themselves, the users became comfortable with positioning the phone at the correct distance and angle to the code after a few attempts. The pop-up text supported a sense of immediate engagement. This helped compensate for the delay incurred by the download times[1]. The height of the signs attached to railings or positioned in shop windows made them comfortable to read. However, considerable difficulties arose for signs positioned on lamp posts. Because of health and safety clauses in the planning laws we alluded to earlier, signs on lampposts had to be positioned at least 7ft off the ground. Some users benefited from the persistence of the pop-up text: as soon as they saw it appear with the phone held close to the code, they could lower the phone to where they could more comfortably read it and click to activate it. However, for several users the codes on signs proved awkward and in some cases impossible to read. This was a source of considerable frustration for them. This highlights again the important practical considerations affecting the real-world deployment of these codes in urban environments. These need to be considered in future applications of this technology for location-based services.

4.2 Engaging with place

We move on next to discuss how the application allowed users to engage with their environment in new ways. This was partly because of the design of the content, and partly due to features of the technology – in particular, its precision and mobility. Content design and technology were sometimes closely linked.

Specificity of Content and Precision of Location

One way of creating engagement was by direct reference to specific physical features of the environment that would otherwise have gone unnoticed by users.

"I didn't know what those things [pulleys on top of Custom's House at point 1 in Plymouth] were – I had never really looked at them before…Normally It's part of

[1] The download times for the top-level WAP pages were kept to a minimum through careful content design which restricted the page to a short amount of text and a picture. Additional links on the top level pages pointed to further text content and audio clips.

your environment and it's just there but when you hear people talking about it and what it is used for – you start thinking about what it is used for and that – you wouldn't normally bother thinking about it – it's quite interesting."

Certain characteristics of the technology play an important role here. First, by enforcing the users to stand in front of the signs to trigger content, it provides a good level of precision for the starting location of the user. This helps in the design of the content in terms of pointing things out that to users that they will be able to see from there or how to orient themselves to be able to see other things. In our observations we noticed the users looking at features of the environment in response to the content – interleaving glances at the content on the phone screen with glances around the environment. Likewise with the audio, people would be listening to the commentary and then turn to look at something in particular that was mentioned. When asked why he was looking around, one user commented:

"It was in response to what I was hearing on the phone – so if you look down towards Clyde Bank you can see the old docks which is probably the busiest part of the Clyde. It's quite interactive when they say you can look down that way and you can."

The users' experience of combining the digital content together with particular physical features of the environment in this way is reminiscent of what Reid *et al.* (2005) called *magic moments*. The experience of these magic moments was dependent on a close coupling of the content with the physical features in the environment to which it referred. This close coupling, in turn, was enabled by the second key feature of the technology, namely the mobility of the phone. The mobility of the phone and the content allowed people to turn around or even move away from the walk point signs to get to better positions to view the reference objects – looking at or listening to the phone as they did so. Some of the content explicitly tells the user to move in this way. For example, "turn around to see the flag flying on the flagpole." What is important here is that location-based content is dependent on not just the precision of the initial trigger but also the ability to move and use the content as the circumstances dictate.

That point about the freedom to move was interesting to us because, in our earlier studies with this technology, some people felt that once they had read the code, they needed to stay close to the sign or poster in order to continue receiving the information to the phone. While such a mental model was incorrect from a technical point of view, the perception of the printed materials as the *source* of the electronic content led some people to conclude a need to stay near to the code. These confused user models might have damaged some of the benefits of this technology in terms of mobility of consuming the information, but fortunately it was not borne out in the application.

Experiencing Place through Characters

One way in which people engaged with the sense of place but which depended on content rather than technology was through the people that lived there. Some of the content was based around famous historical figures associated with a particular place or building. Actors' voices were used to create mini-dramas or simply retell how the environment was different in their day or how particular places were part of famous episodes from their past. Other aspects, though, involved everyday people and workers representing what life in that location was like through their personal anecdotes or recollections related to the place. This kind of content required the immediate environment to be viewed in a different way. It wasn't simply about looking at specific features in the environment but rather using the general environment to facilitate imagination of context around a particular episode or period of time. It was typically presented through the audio medium and many users enjoyed these aspects because they conveyed a much more human side of the location, giving it a richer "sense of place" relative to some of the dry facts conveyed on a short web page. The richness of the audio in terms of the sound effects, local accents and emotions seemed to better support people's imagination than text alone.

"They have actors' voices as well so it makes you understand it better and it's also more interesting. They have like prisoners speaking. If you read that in the text you wouldn't get the feel of it - it makes it more exciting – you can imagine it as well like what it used to be like when you hear the voices."

In the following quote we get a sense of the emotional engagement with place by a user while listening on the audio to a local soldier reminiscing about the war at a war memorial in Plymouth:

"That soldier – there wasn't actually any information really but it gets across the feeling of war – how bad it is. He sounded really sad – it makes you feel sad. When you hear someone talk about their friends that have died it makes you think about it. If you had read it 'my friends died and they had no life' it would have sounded a bit heartless maybe but when you hear someone say it and you can hear their emotion come across and everything it makes it more important I suppose."

Spreading the Experience over Space and Time

We mentioned above the fine-grained control over timing that the deliberative camera phone technology affords. More generally, the users controlled their level of engagement through a variety of choices concerning where and when to experience the content, in ways that the technology facilitated. To begin with the question of "where", the more reflective engagement with the kind of content illustrated in the preceding quote had implications concerning the user's proximity to the sign while consuming the content. We observed a number of examples where people moved

from the sign to find somewhere to sit or lean while listening to the content and quietly reflecting. The mobility of the phone and ability to detach from the trigger point enabled this.

The level of interest with particular content differed from walk point to walk point and from person to person. People made decisions about how much content they wanted to consume at particular points. What was useful about the content was that its pyramidal design allowing users to get some quick high level things or dig deeper for more content. In this respect there were times when some users preferred just to read the top-level WAP at particular points– it was quicker and more in the moment than the audio content – which, while much richer, took longer to consume. Only at particular points of interest did these users delve deeper.

"The text has intrigued me. Now I've got to phone the number… [Listens to audio]…Very interesting. It's saying about the tunnels were closed in 1987 – I've never heard of these tunnels. Apparently they were for transferring horses and carts over to the other side to save them going down to the ferry a bit further down – it's probably something I'll look more into to find out more information when I get back home."

What is of particular interest about this episode is how people's engagement with the environment extends beyond simply the typical "here and now" focus of location-based technologies. That people want to follow up on some of their experiences away from the actual location (for example, when they get back home) indicates how the code reader's History section might come to be useful. It also points to potential technical opportunities for supporting how collected location-based content can be used elsewhere to facilitate follow-up web searches, for example.

4.3 Engagement with Others

In this section we explore ways in which the location-based technology affected engagement with others, both familiar and unfamiliar to the users. Recurring themes are the implications of the technology's visibility and mobility.

Including the Group

We turn our attention first to familiar others. Many of the users did the walk with someone else such as their children, friends or partners. The technology (in particular the mobile phone as the content receiving device) played an important part in facilitating these social experiences, in several ways, despite its small form factor. The first point is a subtle, yet important feature of the technology, namely its visibility to others. The act of pointing the phone towards the sign to initiate the location-based interaction renders the triggering of content a visibly understandable behav-

iour to others in the group. This allowed the group to coordinate more effectively to share new content, for example to move to the person holding the phone.

We observed sharing the content in a number of different forms. There were examples in the observations where users were seen to move together and huddle together around a single phone and look at the images and text together or listen to the audio on the mobile phone loudspeaker. Sometimes this grouping happened spontaneously whereas other times users made social gestures with the technology to invite others into the experience of the content. For example, orienting the phone screen towards the other person or switching on the loudspeaker were both used to signal an invitation to share the content. Again, coordinated movement of the group around the content was facilitated by the ability to move the phone away from the trigger point (walk point sign) and take the content to a position that suited the group. Under certain circumstances (for example, when traffic noise drowned out the loudspeaker, or when the group was too big for all to see the screen) users also shared the content indirectly with others by reading bits of content out loud or providing a verbal précis of the audio content to the group. So while it wasn't always possible for everyone to share directly, this work-around still allowed a shared experience to be created out of the location-based content.

"As I was reading – we were up by the war memorial with the globe on the top – in the text it said the top was damaged by the balloon we had a bit of a family discussion on how that would have taken place. We had conversations over most of the points really. [it was different from a normal walk] because you are sort of discussing and talking about things that you didn't necessarily know before hand –and we made several references to how good it was that way."

As we can see here, the sharing of the content then became a basis for further conversations, with members of the group exchanging reactions to points of interest but also leading to related personal anecdotes. In this way the social experience was sometimes richer than a bounded conversation around the location-based content itself, providing an opportunity for people to learn and share things about each other. This confirms the findings of research into museum guide applications [2].

These social experiences around location-based content also extended beyond the here and now with several users speaking to other people after their walk about things they learned on the walk. In one particular example of these post-walk conversations, one user used the code reader's History screen to revisit content she had seen on the walk in order to show her neighbour the things she had seen[2].

"I showed them – you know because you could bring it back up, the clips that you had done on the walk – I showed them the one about Dracula – the end of the pier one – and she was like ah I didn't know about any of that… Because I said I was

[2] Most of the users were unaware of the History section, which shows a list of previously activated codes. However, this data point suggests some potential value of it for these purposes of retelling stories to friends and family at a later date

doing this walk she was asking me about it and she was saying – yeah, it's a good experience."

Strangers

The second aspect of engagement with others we wish to discuss arises from the location of these walk points in public urban spaces whether other people will be milling around. As we have argued earlier, with this kind of location-based technology the interaction is visible to others around. This visibility influences the social and psychological context of these interactions. We see evidence for this in some episodes from the data. For example, there were instances of strangers coming up to the users as they were reading codes and asking them what they were doing, or whether the codes worked. In other instances, some users reported feeling self-conscious in front of others when trying to read some codes, particularly when they were positioned high up. The point here is not that these effects are or will be universal. Indeed, one would expect some of the curious looks of onlookers to go away as the technology becomes more commonplace. The point, rather, is that the behaviour is visible to others around. This should have the effect of rendering the location-based interactions more understandable to others nearby, especially when compared to other location-based technologies for which there is no visibility of the interaction to explain people's 'odd' behaviour. The other effect of this visibility is that it renders a person's interest in a particular piece of content visible to others around. The interaction then becomes a source of social evaluation. This of course can be both positive and negative. Regardless of that, it is an important determinant of people's judgments about whether to interact with particular location-based content in public.

The need to be close to a sign when scanning the code had other consequences. On several occasions other members of the public standing around the sign made it impossible for users to access it. For some, this created a potentially awkward social situation in that they would have to ask people to move out of the way to be able to access the sign to read the code. Some users just confidently dealt with such situations by excusing themselves; Others, though, actually deferred to dialing the phone number on the signs to get the location-based content. The phone number allowed access to content at a much greater distance from the signs than using the code-reading method, thereby avoiding any social awkwardness with obstructing strangers.

5 Conclusions

We have described experiences with a camera phone application in which users read located symbols (2D barcodes on signs) to obtain content about their locations. This is a real-world deployment in predominantly urban coastal locations, subject to rules and regulations. By *physically* embedding *symbols*, we have uncovered opportuni-

ties and issues that arise from crossing the conventional distinction between physical and symbolic location systems [7]. On the one hand, a located symbol system is physical: symbols are physically bound to locations, as opposed to being descriptions or names. On the other hand, such a system is also symbolic: no coordinates are involved, and the symbols are tokens that indicate rather than determine locations.

We have described what we learned under three main headings: interacting with signs, engaging with places, and engaging with other people. Those last two topics encompass some general lessons for location-specific content development – for example, the desirability of providing audio in which characters describe the location. Moreover, we argue that some of our experience generalises to related technologies such as RFID tags and infrared or Bluetooth beacons. Their presence sometimes also needs to be represented to humans by "located symbols" such as a printed mark or poster, to help make their association with a particular location intelligible when they otherwise might be invisible.

Just as others have considered the (in)accuracy of GPS, and how to take account of it when designing applications [4], here we have considered what might be termed the *fidelity* of an embedded symbol. This is its degree of "faithfulness" in referring to a point of interest, which may be a physical place or situation. A high-fidelity embedded symbol is one such that someone encountering the point of interest can conveniently find and access the symbol. That entails several physical properties that require designers to take account of users' understandings of the built environment. Of particular note was that the symbol needs to be in the semantic "catchment area" of the physical point of interest. Further research is needed into exactly which architectural features form catchment areas, but we have found that not only walls and other barriers but also entrances and approaches are relevant. The exact way in which symbols are attached is also important, not only for orientation and accessibility, but due to social factors such as whether users might feel self-conscious when reading them. Achieving all the above physical properties can be difficult due to local regulations and constraints. It seems likely that a compromise will often have to be made.

A high-fidelity symbol is also one such that someone encountering it is likely to understand what it refers to, without ambiguity. In addition to positioning, graphical design plays a part in clarifying a symbol's reference and providing context for its use, and in making it easy to find. The graphical design of the sign has to balance visibility and clarity against regulations governing its size and appearance.

Once the design question of how to embed high-fidelity symbols has been tackled for a given situation, we reap the benefits of embedded symbols and the mobile phone as reader and content-player. First, once symbols are embedded, their location is known with considerable precision. That provides an opportunity for content authors since we found that an exact reference to the location of something nearby can give users a strong sense of engagement with the place. However, this entails the author knowing exactly where the symbol will go and how it is oriented, which suggests strong coupling between authorship and the practical task of symbol placement.

We found further advantages for users. The technology is not only a low-effort means of accessing electronic content (where the signs are at a convenient height), but also gives users fine-grained control over when and where to experience that content. The deliberativeness of reading a barcode gives firm control over "when", so the user can access the content when the time is right given social and other considerations. The short-term persistence of the pop-up text and the hierarchical organization of the content allow the user to walk away from the symbol if they so desire, and choose where to experience the content and to what depth. The long-term persistence of the history entries means that they can even (re-)experience the content much later, in another place, perhaps with other companions. That leads us, finally, to the overall significance of social engagement: the visibility of the symbols and phones all contributed to making the user's actions intelligible, and helped users include others.

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