

# Lessons from Touring a Location-Based Experience

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**Abstract.** Touring location-based experiences is challenging as both content and underlying location-services must be adapted to each new setting. A study of a touring performance called Rider Spoke as it visited three different cities reveals how professional artists developed a novel approach to these challenges in which users drove the co-evolution of content and the underlying location-service as they explored each new city. We show how the artists iteratively developed filtering, survey, visualization and simulation tools and processes to enable them to tune the experience to the local characteristics of each city. Our study reveals how by paying attention to both content and infrastructure issues in tandem the artists were able to create a powerful user experience that has since toured to many different cities.

**Keywords:** Location-based performance, cycling, adaptation, Wi-Fi fingerprinting, seams, user generated content

## 1 Introduction

From tours and guides, to games and performances, to educational field trips, there is a growing interest in how location-based technologies can deliver engaging new forms of leisure, entertainment and learning. Early explorations have demonstrated a variety of ways in which such experiences can combine digital media with physical settings to create exciting new experiences. Guides and tours have attached digital media to historic sites in order to enhance understanding [1,2,3,4]. Computer games have been overlaid on real cities, demanding physical engagement from players as they chase one another through the streets [5,6,7,8,9,10]. Other experiences have drawn on the pleasure of physical exploration, either to find digital resources [11,12] or to find physical resources as in the popular pastime of Geocaching [13]. Educational experiences have engaged learners in simulations that appear to be overlaid on the real world [14] and have underpinned field trips to sites of special interest [15,16]. Location-based technologies have also enhanced Live Action Role Play by enabling the creation of apparently magical or paranormal artifacts [17].

Finally, artists have combined digital media with physical locations, props and players on the city streets to create performances that draw on the everyday world as a theatrical backdrop [18].

While these examples demonstrate the potential of location-based technologies to underpin compelling new experiences, they also raise major challenges, especially with regard to touring them to different locations. At the heart of this challenge is the extensive work involved in adapting an existing experience to each new setting in which it is to be deployed, potentially including authoring content, but also rolling out and tuning the underlying location-service and other technical infrastructure.

Although authoring content is a challenge for established digital media such as computer games, location-based experiences raise the added problem of potentially requiring re-authoring for each new setting, with digital assets such as videos, sounds, text, graphics and virtual worlds being created afresh to match local buildings, artifacts, people and other physical assets. Even when previous content is available, it needs to be tailored to fit to new locations incurring considerable additional cost.

After creating assets, the designers have to wrestle with the complexities of location and communication technologies so as to properly locate these within the physical world. Previous studies have shown how challenging this can be, requiring them to be able to reason about the fine details of coverage and accuracy of wireless communications and positioning across a given location [20]. They may even have to actually deploy some new physical infrastructure such as tags and beacons within the new environment. Nor does their work end here, as other studies have highlighted the importance of the real-time monitoring and ongoing orchestration of an experience from behind the scenes once it has gone live [5]. While game-mastering and other forms of orchestration are already practiced with current online games, location-based experiences introduce a new level of challenge to this, as participants are often widely dispersed across a physical location, difficult to identify, and may suffer from frequent disconnections [18].

Finally, these various challenges are mutually dependent, with both the authoring of content and the orchestration of experience depending on the successful adaptation of the underlying technical infrastructure, requiring designers to wrestle with a complex mix of experiential and technical issues at each new location. Unsurprisingly, it remains remarkably difficult to create an experience that benefits from a rich integration of the digital and physical and yet can be easily rolled out across many different locations. Indeed, an inherent lack of ‘tourability’ may be the greatest bottleneck facing the future widespread adoption of these kinds of emerging location-based experience.

This paper presents a study of a professional location-based experience called Rider Spoke that has been deliberately designed to tour to multiple cities. Our study covers the critical fifteen month period from early concept workshops through touring to three cities, by which time it had emerged as a stable product. We focus on how artists addressed the complex challenges of tourability by creating a novel structure that, with only minimal seeding, enables participants themselves to create location-based content as they explore a city, while simultaneously driving the gradual evolution of the underlying location-service. We also describe how the artists iteratively developed new software tools to support the touring process. Our study draws on multiple sources of data, from questionnaires completed by participants that

give insights into their experience, to notes and observations from meetings and performances that reveal the activities of artists and technicians, in order to present a holistic account of the story of Rider Spoke from multiple perspectives.

## 2 From Concept to Premiere

The first half of our study takes us from creating the initial concept up to the premiere performance of Rider Spoke at London's Barbican centre in October 2007 – a detailed examination of Rider Spoke as a cycling *experience* can be found in [19].

### 2.1 The design drivers behind Rider Spoke

Prior to Rider Spoke, our artists had created several location-based experiences and through these, had acquired extensive first hand experience of the substantial costs involved in touring them to different locations. Their primary concern this time was to create an experience that was deeply engaging and yet also lightweight and flexible enough that it could be toured to many different locations worldwide. Early design workshops explored this challenge and homed in on three key design drivers that would underpin Rider Spoke and reduce the cost of touring.

**A commitment to user-driven locally-relevant content.** Participants would populate the experience with content by recording personal stories that others could then listen to. It was important that these stories should be deeply engaging, for example moving, charming or hilarious, but also have local relevance, that is resonate with specific locations within the city which would somehow serve as an inspiration or backdrop for them. Thus, participants would be required to explore the nooks and crannies of the city in order to record their stories and find those of others.

**A lightweight and adaptable approach to location.** The location mechanism would need to be sufficiently lightweight and flexible that it could be reliably deployed and adapted to different cities. Although widely available in principle, the artists' previous experiences led them to reject GPS as being too sensitive to the particular geography of built-up urban environments, especially with regard to variable coverage, and so they were keen to experiment with an alternative approach to location.

**Shifting away from a dependency on real-time data connection.** Unlike many earlier experiences, Rider Spoke would deliberately operate as a disconnected experience, isolating participants from immediate contact with one another so as to create a calm and contemplative atmosphere, whilst also avoiding the severe technical challenges of dealing with disconnection that had dogged previous experiences and required extensive orchestration.

From these three principles emerged the detailed design of an experience that involves individuals cycling through a city at night, recording and then listening to personal stories that are associated with particular locations. It was felt from the start that travel on foot was too spatially constraining and that some form of transport would be required to enable a sufficiently wide ranging exploration of the city. Cars were briefly considered, but cycles were soon settled on as they allow exploration, can access a wide range of territories, help isolate players and yet still deliver a visceral experience of the city. It was also decided to stage the experience at dusk and into the night so as to heighten the sense of an unusual, even otherworldly, experience of the city as an inspiration for stories. Participants would therefore cycle through the city at night. The artists themselves expressed their intention in their documentation as follows: *“As you roll through the streets your focus is outward, looking for good places to hide, speculating about the hiding places of others, becoming completely immersed into this overlaid world as the voices of strangers draw you into a new and unknown place. The streets may be familiar but you’ve given yourself up to the pleasure of being lost.”*

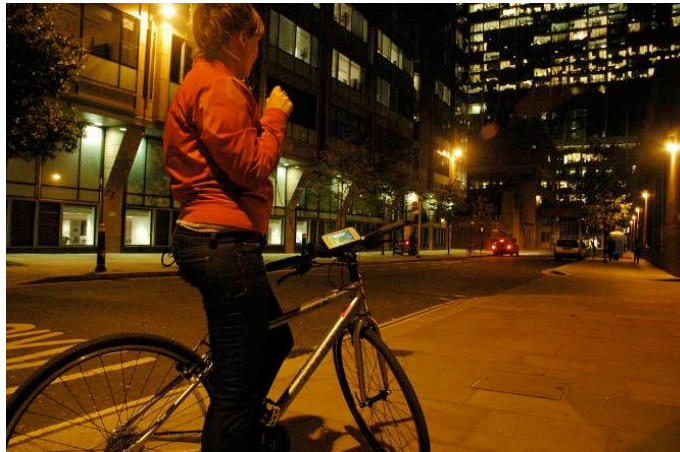
## **2.2 A participant’s view of Rider Spoke**

Participants arrive at the hosting venue, either on their own bicycle or to borrow one. They register at the reception where they sign a disclaimer and leave a deposit. They then receive a briefing that covers the nature of the experience, how to use the technology, how to cycle safely, and also tells them of an emergency paper map and phone number under their saddle. The receptionist logs their details in a database and then sends them outside where a technician mounts a mobile console (a Nokia N800) onto the handlebar of the cycle and, for loaned cycles, adjusts their seating position so that they feel comfortable and safe. Riders leave the venue individually and the experience lasts for an hour. After the first few minutes cycling, gentle music plays, setting the tone for the experience, and a narrator begins giving instructions. The female voice is calm and measured, adopting a style and tone reminiscent of a psychotherapist:

*This is one of those moments when you are on your own; you might feel a little odd at first, a bit self-conscious or a bit awkward. But you’re alright and it’s OK. You may feel invisible tonight but as you ride this feeling will start to change. Relax, don’t forget to breathe both in and out and find somewhere that you like, it might be near a particular building or road junction, it might be near a mark on a wall or a reflection in a window. When you have found somewhere give yourself a name and describe yourself.*

The rider’s first task is to find an appealing location, stop, and record a name and description, as shown in figure 1. This location has to be a ‘new’ location within the experience, meaning one that is not already occupied by an existing recording (according to the location technology that we describe below). It is the basic rule of Rider Spoke that each new recording has to be made at a new location, requiring players to continually seek out new places in the city as the volume of recordings

grows. When the Rider has found a valid location the console screen displays the invitation shown in figure 2.



**Fig. 1.** A rider with console attached to their bicycle listening to a recording



**Fig. 2.** Inviting a rider to record their description

The interface is designed to be distinctive and yet simple, providing just a few options to record and listen to messages. After all, Riders may be using this device for the first time while engaged in an unusual experience that also involves cycling. The overall metaphor is one of hiding and finding recordings within homes. Artistically, the design draws on a combination of Mexican votive art, with religious associations of prayer and offerings, combined with images of tattoos that are emblematic of voyages of exploration. Interaction is via a touchscreen using just a few large buttons and with safety in mind, the briefing and instructions encourage riders to stop before interacting.

Following this initial task, riders can repeatedly choose between recording an answer to a new question or listening to others' recordings, repeating this choice until their allotted time of one hour has elapsed. To answer a question, the rider must again find a new location. They will then be asked a question (over the audio in their headphones) that encourages them to divulge a personal story of some kind. The questions, authored by the artists, ask riders to reflect on significant, evocative or hilarious moments of their life while engaging with the city. For example, they may be asked to reflect on people or events in their lives:

*Please will you tell me about your father. You might want to pick a particular time in your father's life or in your life. Freeze that moment and tell me about your dad: what they looked like, how they spoke and what they meant to you. And while you think about this I want you to find a place in the city that your father would like. Once you've found it stop there and record your message about your father at that moment in time.*

Or they may be asked to use the places and strangers in the city as inspiration for their imagination:

*I want you to look for a flat or a house and find a window that you would want to go through. I want you to stare into that window and tell me what you see and tell me why you want to go through that window*

Riders are given the opportunity to review and record their stories and then to save them when they are satisfied. On choosing to listen to other's recordings, the rider is offered a list of the three nearest recordings to their current location. As a result, recordings are always available to be heard, although cycling through the city will continually update the list, effectively browsing a landscape of stories. When the experience is near its end the narrator gives the rider one final task: to make and record a final promise. After this, they return to base where the device is dismantled from their bike and their deposit returned.

### **2.3 Implementing Rider Spoke**

A substantial portion of our study is concerned with how the artists adapted the technical infrastructure of Rider Spoke, and so it is necessary to delve into some details of its implementation, especially with regard to the design of the location service and database. The design team elected to exploit the prevalence of Wi-Fi in many cities as the basis of their location service as previous research had shown that Wi-Fi could provide a sound basis for a location service [21]. After some initial experimentation, the team elected to develop a bespoke Wi-Fi location service that was tailored to the particular requirements of Rider Spoke, basing this on an existing technique called Wi-Fi fingerprinting [22,23]. The rider's console periodically scans for Wi-Fi access points as they traverse the city. The resulting list generated at any moment is taken to be a distinctive fingerprint for their current location. If this fingerprint is deemed to be different from already known fingerprints held in a

database then it becomes a new location. If it is very similar, it is considered to match an already known location.

As players record stories, some of these known fingerprints become associated with recordings. The database also records adjacency links between fingerprints that are created whenever one fingerprint is seen directly after another. Thus, the resulting database takes the form of a mathematical graph, with nodes being fingerprints and edges representing direct adjacencies between these. These adjacency links enable the location-service to reason about the relative proximity of locations by working out the minimum number of links that separates them. Thus, it becomes possible to work out the likely 'nearest' recordings to a given location.

Each rider begins with a preloaded version of the database on their console from the previous day. Any new locations and data that they generate during the experience as they make recordings and explore new parts of the city are offloaded back to the central database when they return (remembering that this is a disconnected experience). At the end of each day all new locations and new recordings from that day's participants are merged back into the database. This requires the artists to filter and merge the new recordings, working out which should be made available to future riders. This involves listening to all of the recordings from that day and making two key decisions. First, is a recording engaging enough to warrant it being included. Second, where two new recordings are associated with the same new location (two riders having independently discovered and used it on that day), which should be kept and which thrown away in order to resolve the conflict.

Thus, the graph structured database of known locations, adjacencies and recordings grows and evolves as the experience unfolds over many days. The strength of this approach is that the content and location information evolve from practically nothing as the experience gradually rolls out over the city. A little seed content, normally of the order of a few tens of recordings, and a small fingerprint graph that can be built from a few short test cycle rides around the venue, is all that is required to prepare the experience.

It is important to note that this approach does not deliver, or aim to deliver, the geographical position (coordinates) of a fingerprint; it is therefore not a positioning service as are some other Wi-Fi-based services. However, it does satisfy the essential requirements of Rider Spoke, namely being able to identify new and existing locations to a mobile console, associating some of these with content, and reasoning about their relative proximities. Of course, there is still a question of 'accuracy' in the sense that recordings ideally need to be heard near to any physical locations to which they refer. However, this is deliberately a relatively fuzzy association and so the experience is carefully designed not to rely on accurate positioning. Early seed messages that are deposited by the artists are carefully constructed to be engaging but also locationally-vague as these may be potentially heard from far away while the initial graph is small and sparse. As the database grows and the graph becomes ever more dense, it should be the case that the three 'nearest' recordings are increasingly from locations that are actually nearby.

## 2.4 Feedback from the premiere performance

The premiere performance of Rider Spoke took place in London in October 2007, being experienced by 548 riders over 8 days. Between them they left 1,964 audio recordings in the city (average of 3.5 per player and maximum of 10). All riders were invited to give feedback after the event via a web-based questionnaire that probed their background, overall enjoyment, and the themes of recording and listening to stories, finding locations, and cycling. Given that this was a public event, all of the participants were self-selecting, as were the 71 (13%) of these who completed the questionnaire. Responses were quite evenly distributed across the 8 days of play, with no day receiving less than 5 or more than 10. 41 respondents were female, 28 male, and two didn't say. Most were attracted by the novelty or by the artists' reputation, and some by the cycling (54 classified themselves as 'cultural/arts events visitors' and 29 as 'cyclists'). Over half cycled regularly and 31 used their own bikes. However, 2 claimed to 'never cycle'!

The overall reception to Rider Spoke was very positive. On a five point Likert scale, 70% of respondents agreed or agreed strongly that 'taking part in Rider Spoke was fun' while 67% said that they would do the experience again. While it may of course be that those who felt most positive were also the most willing to complete the questionnaire, this fits well with anecdotal feedback that we received from riders as their returned to the venue. It appears that riders appreciated several aspects of the experience.

They enjoyed recording and listening to stories which could at times be deeply personal and apparently honest, and some even cried while recounting them: "It was a very 'moving' experience for me and very memorable. To be alone in the city, holding your bike, blubbing about your father on a Sunday evening is something else...!" Others, however, invented stories: "*I was much more performative. I often made things and characters up to make it interesting, both for me and the other listeners*". Listening to other people's stories could also be moving, again especially when they were personal: "*One about the memory of a man's father. It was extremely touching – he also described standing on a roman wall, an evocative historical location to be thinking about memories. He even vowed to bring his dad to that spot because he thought he'd like it there. Beautiful.*"

Respondents also remarked on the distinctive social nature of the experience, which as one put it, involved "*a disconnected intimacy with a total stranger.*" This was amplified by the feeling of being isolated in the city: "*It was a private moment strangely enough not always in a private space.*" This is not to say that riders were not aware of bystanders though, which for some introduced a further sensation of being exposed and even slightly vulnerable.

Location played an important role in inspiring stories, with players choosing movie-like backdrops for their recordings: "*I just found places that excited me to stand in, that would be seen in a film.*" and "*When hiding in old alleys that reminded me of what Victorian London might have looked like, I think I romanticised the answers a bit more.*" Ambient sound was also important and would directly appear on the recordings: "*Yes - sometimes the background noise or the atmosphere of a particular place really chimed or sometimes jarred with the words I was speaking. This added a layer of richness to the testimonials.*" Some locations imparted a



personal meaning: *“I followed a route that I like and stopped at places that had personal resonance or geographic prominence.”*, while others were simply aesthetically pleasing in their own right: *“Cos they were quiet and beautiful in their own way.”* Yet others were associated with a memorable landmark: *“I looked for spots which were quiet and had some kind of marking point - as if it was buried treasure, so like a squirrel I could always find it again if i wanted to!”*

Finally, cycling appeared to engender a sense of freedom and liberation in some that may have opened them up to recounting stories. *“I love cycling and haven’t cycled regularly for a while as my bike broke and i have not got round to fixing it! So it reminded me of the freedom i feel when I cycle and to cycle with no destination is wonderful - i felt physically awakened and engaged”* and *“Made you look, made you stare, made you investigate dark places you wouldn’t normally.”*

This is not to say that all players had a great time and that all stories were deeply engaging by any means. Many stories were not greatly interesting, others were unintelligible, and there were clearly moments when players found themselves in a completely inappropriate location: *“I wasn’t going to speak at length about my father whilst standing in a grimy back alley that stank of excrement.”* Some players got lost, while others commented on being cold, tired, uncomfortable and even in desperate need of the toilet while cycling. Perhaps the most frequent criticism, however, arose from the slow response of the interface which could take many seconds to respond on some occasions as we discuss below. However, it does seem that on balance, the distinctive combination of freedom, isolation, vulnerability, disconnected intimacy, location, physicality and of course the artists’ questions provided a framework within which many riders could create powerful content.

## **2.5 Lessons for the infrastructure**

While the artists were generally satisfied with the overall user experience, the technical challenges involved in delivering Rider Spoke proved to be more problematic. These revolved around two issues: the overhead of filtering content and the somewhat opaque and inflexible nature of the location mechanism.

Given the high-profile and often unpredictable nature of a premiere performance, the artists were prepared to devote a large amount of their own time to the hands-on running of the experience, and had also been willing to hire a relatively large crew to support them. This had made it (just about) feasible to listen to and filter hundreds of new recordings each day ready to be merged into the database for the next day’s play. However, future touring would need to rely on a smaller crew to be financially viable, and would also have to demand less time from the artists themselves as it would take place over many years to come when they would be working on new projects. Concerns were also raised about how filtering would work with overseas touring where recordings would not necessarily be in English. Improving the filtering of content was therefore identified as a key bottleneck to be addressed to support future touring.

The second issue concerned the location mechanism. Collectively our riders logged 1,236,120 distinct sightings of 3990 unique fingerprints (locations) over the 8 days. The size of the resulting graph was a major contributing factor to the poor

performance of the console software. Discussions between the artists and the technical team after the first few days revealed that it was not possible to retune the mechanism to produce a new smaller graph. Even if it had been, it was unclear what density of graph would be needed anyway. A large and dense graph could clearly cause performance problems and also make it possible to appear to place many recordings at each physical location. Too sparse a graph however might not provide sufficient locations for new content and could potentially lead riders to perceive mismatches between content and location (which had not been a significant factor in user feedback from the premiere). Furthermore, it was not clear how variations in Wi-Fi density across different cities, or perhaps even across a single city, would impact on tuning the graph. Being able to tune the fingerprint graph to match the local characteristics of each new city was therefore felt to be also important to the future touring of Rider Spoke.

### **3 From Premiere to Touring**

The second part of our study considers the work that was done to address these challenges as Rider Spoke toured through two further cities, Athens in March 2008 and Brighton in May 2008. While nearly all aspects of the experience were tweaked to some extent (questions revised, briefings updated, and the software on the console restructured to improve performance), the greatest effort was invested in developing tools and processes to support filtering of content and tuning the location mechanism.

#### **3.1 Managing the user generated content**

Filtering recordings needs to address three issues. First is selecting the best content so that it can be merged into the database and made available to future riders. The aim here is to both reduce the volume of content to a manageable amount, ensuring that enough locations remain free for the new players, and also to ensure that the content is of the best possible quality in the opinion of the artists. Second, is the need to resolve conflicts where two new recordings occupy the same location. Third, is the challenge of dealing with multiple languages. Many riders in Athens wished to record their stories in Greek and the artists (who did not speak Greek) felt that the recordings would be of higher quality if this were the case. To be able to tour Rider Spoke, the artists needed to be able to outsource the task of rating content to trusted people who could be hired in as needed, including native speakers. The first step was development of the following five point rating scale and guidelines as written down in the ‘Operator Manual’:

*1. I can't hear this/ would never want to listen to this. Inaudible. Very long silences. Criticizing the work: "This is boring". Repeated answer: i.e. an exact copy of this answer already exists*

*2. I wouldn't want to listen to this. Boring: an observation or sentiment that is completely undistinctive or obvious "Some parts of the city are quite rough" "I went*

*to lots of wild parties when I was young". These answers lack anything specific, precise or personal. They are often very short. An answer that is almost exactly the same as a previous answer*

*3. I wouldn't mind listening to this. Average: a typical answer but nevertheless one that has meaning to the person speaking. "I promise that tomorrow I will be kinder to my work colleagues." "I went to a party when I was 15 and tried to kiss a boy called Peter but before I could I threw up ..."* The majority of answers will be 3 and, if you are not sure what score to give, mark an answer as 3

*4. I would enjoy listening to this. Outstanding. Contains a unique or specific insight or revelation. Something that no one else has said. Makes you laugh or moves you.*

*5. I would love to listen to this. Exceptional: hilarious, moving, surprising, unique. Not necessarily long: it could be very short*

The artists also proposed the following modifiers:

*If an answer is location specific (i.e. refers to a specific building or street so that another player would know what they are talking about) +1*

*Any answer to "describe yourself" (because these are usually short and introductory) -1*

*Any answer to "make a promise" (because there are so many of them and they can be very repetitive) -1*

*Very brief (don't forget the effort that a player will have gone to in order to hear an answer: if an answer is very short then it may seem like a big anticlimax unless it is especially strong) -1*

These guidelines were then embedded in a web-based ranking tool. One of the screens in this tool presented cases where multiple new recordings conflicted with a single new location. The tool also allowed the artists to choose a ranking threshold (1-5) such that only recordings rated above this would be merged into the database. This could be raised over time as higher quality recordings became available. In each of the three performances the ranking began at 3 on the first day and had been raised to 4 by the end (retaining 10%, 13% and 20% of the recordings in London, Athens and Brighton respectively).

The work of ranking was usually shared out among the artists who could review prior rankings day-by-day to allow for ongoing artistic oversight and the review of one another's judgments, whilst keeping the task at a level that was practically manageable. Artists also became much quicker at the task as their familiarity with the content and this new tool grew. Furthermore, the use of the ranking tool and how the above gross categories and rules might get applied was something that itself evolved as the experience became more populated with content and the artists listened to more recordings. Rankings could even be pre-reviewed within the current session to get a feel of what the overall batch of recordings sounded like in advance of the final ranking at the end of the day. In this way ranking sessions and the use of the ranking tool within them became a fine-tuned and highly nuanced resource for keeping content captivating and up to date. In addition, a particular attentiveness to locally-grounded stories enabled the artists to further refine the location-specific tuning of the

experience and imbue the whole event with a sensitivity to the character of the locale that it would otherwise have lacked. Finally, being web-based allowed the task to be carried out remotely, further reducing touring costs and allowing the sharing of the work across the team of artists.

### **3.2 The complexities of the location mechanism**

Tuning the location mechanism to each new city was the second major challenge for touring Rider Spoke. It also proved to be a considerably more knotty problem to resolve. Given that the artists spent considerable effort trying to understand the technical details of this mechanism, it is necessary for us to briefly consider them here too.

The location mechanism goes through several steps to decide whether the list of currently visible Wi-Fi access points represents an existing or a new fingerprint (and hence location). Wi-Fi scanning software scans every few seconds, returning a list of all currently visible access points, each represented by its MAC address (the unique address pre-programmed into the access point) along with the received signal strength with which it has been seen. Access points below a configurable signal strength threshold, are then removed from the list because they may be susceptible to transient interference and their inclusion could lead to highly unstable fingerprints. After this, only a limited number of the remaining access points are considered, according to a configurable fingerprint size parameter, with the weakest signals being discarded. The result of applying these two parameters is a manageably long list of access points, each of which is associated with a reasonable signal strength. The resulting list is then compared against the local database of known fingerprints (the fingerprint graph). If the filtered access point list “overlaps” an existing fingerprint by a sufficient amount – specified by a third overlap threshold parameter – then the new sighting is deemed to match an existing fingerprint. If not, it is deemed to be a new fingerprint and is added to the fingerprint graph along with a new edge that connects it to the most recently sighted fingerprint before this. The overlap is the proportion of access points that are in common between the two lists, for example “A,B,C” and “A,B,C,D” have a 75% overlap. Choosing a value of 100% for the overlap threshold would require that access point lists match exactly. In this case any difference in the list would produce a new fingerprint and hence a new location. Conversely, smaller values allow an existing location to be found again if a subset of the access points are not visible, for example if they have been temporarily turned off.

In summary, the three key parameters of signal strength threshold, fingerprint size, and overlap threshold control how raw lists of access points and signal strengths are mapped onto distinct fingerprints and hence locations. Collectively, they determine the density and stability of the resulting fingerprint graph. The artists can change them to produce, on the one hand, a graph with very many but possibly transient locations, and on the other, a graph with relatively few but more stable locations. The goal is to find the correct combination that produces enough locations for a given city so that riders can find new locations at which to place their stories, and yet not so many that it feels like too many stories are at each location or that it is difficult to ever find a story again after it has been recorded.

Discussions with the artists revealed that it was difficult both to understand and predict the effect of changing individual parameters (not least because they overlap to some extent in their ultimate effect). Setting them for the London performance had been largely a matter of guesswork and the result had clearly not been optimal. It also seemed highly likely that these parameters would need to be tuned to suit the particular local distribution of Wi-Fi access points across each new city so that a more principled approach was clearly needed.

### 3.3 Tools to adapt the location-mechanism

The team therefore created a suite of three software tools to help localise Rider Spoke to each new city. A *survey tool* was used to gather some initial Wi-Fi data from the city, along with GPS data that could subsequently help georeference this to maps of the area. A *simulation tool* processed this data, enabling the artists to very rapidly create many different graphs, arising from different parameter settings, and rank and compare. Finally, a *visualisation tool* revealed the likely distribution of a given fingerprint graph across the chosen area of the city.

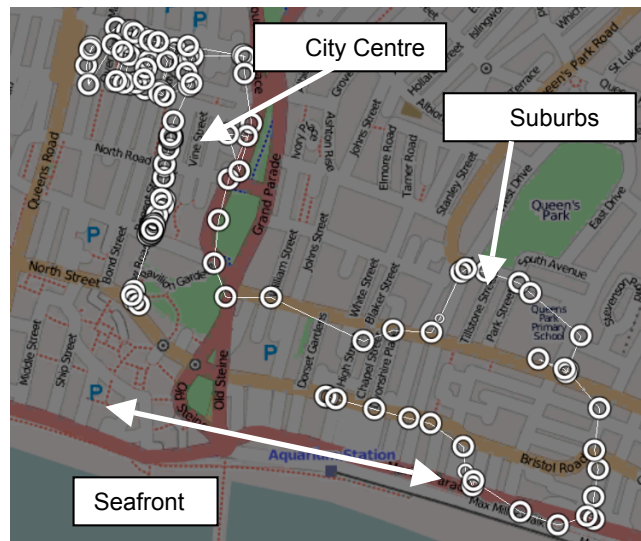


Fig. 3. Geo-referenced visualization of Brighton survey

The survey tool required someone to cycle several pre-planned routes through the city with a mobile logging device to cover likely places that riders might visit during the experience. The artists aimed to get a broad brush picture of the environment in as short a time as possible. The Athens survey was conducted by four artists in parallel and completed in about one hour. Here, the different routes were arranged so that they would cover different areas, but also contain some overlap with other routes to make connections in the fingerprint graph. The Brighton survey covered the busy city centre, the suburbs and the seafront and was completed by a single artist in about one

hour. These surveys were carried out weeks in advance of the performance alongside the usual site inspection and discussions with the hosting venue and the survey data was then taken back to the studio for analysis.

The simulator tool allowed the artists to conduct a series of ‘what if’ experiments by feeding the survey data into the fingerprinting mechanism as if live and then stepping through ranges of values for each of the three parameters so as to automatically generate hundreds or even thousands of different fingerprint graphs. These graphs could then be sorted according to basic metrics including the number of fingerprints and edges they contained. An additional metric called ‘retrievability’ was introduced to capture the artists’ requirement that “content and fingerprints must be easy to find”. This was defined to be the total number of fingerprint sightings divided by the number of unique fingerprints generated for this graph and helped the artists find parameter settings that yield a graph whose locations might be suitably easy to find. By sorting and sifting to compare these various metrics across many graphs, the artists were able to home in on parameter settings that might hit the sweet spot of a good number of locations that were reasonably retrievable.

Finally, the visualisation tool enabled the artists to inspect selected graphs (chosen from the simulation), examining their topologies (the clustering and connectedness of fingerprints) in relation to the geography of the local area, as shown in figure 3. The graphs could be drawn as abstract visualisations to reveal their topology, but these could also be pinned onto to various geographical maps and satellite views of the local area in Google Earth.

## **4 Populating the City with Stories**

In its varied detail, our study has revealed how Rider Spoke combines a distinctive mode of interaction (cycling through a city at night and recording and listening to personal stories) with a novel technical infrastructure (an evolving graph of locations determined through Wi-Fi fingerprinting) to create a unique experience. The ultimate success of this approach is perhaps best demonstrated by the continued popularity of Rider Spoke as a touring product. At the time of writing it has been performed in London, Athens, Brighton, Budapest, Adelaide, Sydney, Copenhagen, Bristol, Edinburgh and Linz, with further bookings pending. That Rider Spoke is both engaging for audiences (and promoters) and yet also tourable can be largely attributed to the way in which both experiential and technical issues have been addressed in tandem through a process of iterative design and testing ‘in the wild’ of public performance. However, beyond documenting a ‘unique’ experience, what more general lessons can we draw out for HCI? What can the designers of other location-based experiences and technologies take away from this study?

**The co-evolution of content and infrastructure.** As already mentioned, the critical feature of Rider Spoke is the way in which both the content and the underlying location database evolve in tandem over the lifetime of the experience as a result of participants exploring the city. This enables the experience to be quickly rolled out across each new city without the need for extensive pre-authoring of content, or surveying or deploying underlying infrastructure, directly addressing two major bottlenecks to touring location-based experiences.

**User generated content.** Web 2.0 services such as Wikipedia, YouTube and others make use of friendships, subscriptions and users' ratings to motivate 'user generated content' and ensure that the most interesting content becomes the most publicly visible (see [24] for a discussion of collaborative editing in Wikipedia for example). Rider Spoke also relies on user generated content, but in a different way. First, it provides a distinctive framing for storytelling in which anonymity and isolation, rather than friendship and discussion, are used to encourage powerful performances by members of the public. Second, the artists retain a high degree of editorial control over the final rating and filtering of content that is published back to the users. While having the artists rate content clearly limits the scalability of Rider Spoke (while ensuring high quality), it may be that other applications that employ user generated content can learn from its approach to carefully framing storytelling to enable the public to perform.

**A 'placeful' experience.** As a location-based experience, Rider Spoke is also able to draw on specific places in the city to provide rich and often personally meaningful backdrops for stories. Furthermore, participants are required to explore the city in order to find and create these locations for themselves rather than having the artists choose or create them in advance. In other words, in a location-based experience, creating locations can be as much a part of user generated content as recording audio or video. Rider Spoke is also distinctive in that it does not fix locations to absolute positions or demand a high degree of accuracy. One way to view its deliberately fuzzy approach is, as Harrison and Dourish have previously argued [25], that it emphasises a sense of place rather than a consideration of the absolute geometry of the space of the city which would have arisen from adopting a more positioning-oriented approach. However, as Dourish suggests also when subsequently revisiting this argument [26], the division between place and space is sometimes less clear. We would suggest that what we see in Rider Spoke is the development and deployment of a technology that presents a 'user generated spatiality' to users with "people creating space through their movement" [27] as they cycle through the city.

**Tools for flexible and adaptable location services.** Finally, our study has also shown that evolution of the infrastructure requires careful management in much the same way as the user driven evolution of content. To be effective this user driven infrastructure needs to be adapted to local conditions (in our case to the local geography and variations in the distribution of Wi-Fi) and this requires careful attention and the support of dedicated tools that enable designers to survey, simulate and visualize the likely evolution of an infrastructure across a particular city and to be able to tune it as a result. This capability to reveal the nature of the technical infrastructure to the designers of location-aware experiences reflects an ongoing discussion of ‘seamful design’ within HCI. Previous papers have observed how the characteristics of the underlying infrastructure of positioning and wireless communications can have a major impact on the user experience and how, far from being an occasional glitch or bug, this is an ongoing aspect of such experiences that needs to be recognized by designers [20]. Lack of coverage or accuracy can be characterized as ‘seams’ in the infrastructure, a natural part of the fabric from which it is knitted together. Various approaches to dealing with seams have been proposed including removing, hiding, managing and even exploiting them [5]. Work on seamful games has explored the latter approach, demonstrating and studying a series of examples in which partial coverage of Wi-Fi and/or GPS becomes a resource in the game that can be exploited by players, for example, by being able to hide in the ‘GPS shadows’ [10]. Other work has explored the approach of revealing the infrastructure, arguing that authoring tools that allow designers to overlay digital assets onto a map or image of a physical location need to be extended with an additional infrastructure visualization layer that enable designers to take account of the availability of the underlying infrastructure across specific locations [27]. Our study has demonstrated the power of this latter approach, providing our artists with a series of tools for exposing the characteristics of its location mechanism across each new city. Part of this certainly involves overlaying visualizations of the infrastructure on maps as we see in figures 5 and 6. However, it also requires additional tools for surveying each site and for experimenting with various settings of parameters so as to explore different possible scenarios. In short, while we agree that designers do indeed need to visualize the underlying infrastructure, we recognize that this is only one part of a complex overall workflow that also involves gathering and experimenting with data and that all stages of this require support from dedicated tools.

## 5 Conclusion

Our study of a touring location-based experience, from its first concept to its emergence as a stable product following three performances in different cities, has revealed how professional artists worked to create an experience that was both compelling and yet also practicably tourable to different locations. We have seen how they developed a distinctive approach that involved participants exploring a city on bicycles, recording and listening to personal stories, which were then filtered and merged together into an evolving database of ‘user generated content’. We have also seen how the iterative development and use of survey, simulation and visualization



tools allowed this to be supported by a location service that also gradually evolved at each city and could be tuned to its local characteristics.

While Rider Spoke itself is perhaps a unique experience, we have also discussed how it embodies general principles that should be of use to the designers of future location-based services. Careful framing of the experience, drawing upon cycling as a distinctive mode of engagement with the city and deliberately isolating participants from one another, while unusual in traditional HCI terms, establishes a frame within which the public are able to create powerful user generated content. At the same time, the development of a platform that can be easily rolled out over a city with minimal seed content, supported by dedicated tools that enable adaptation to each new setting, enables the experience to be easily toured. It is through attention to detail of both content and the technology that the artists are able to deliver a successful experience.

In summary, Rider Spoke shows through its success as a touring product that there are solid, practical ways of addressing some of the core challenges that face the widespread adoption of location-based applications. Indeed, a concatenation of practical, locally-sensible strategies appears to be an inevitable aspect of managing touring location-based services where it is exactly the distinctiveness of particular locales that may trump any effort to create overly generic, standardized solutions. We hope that through the detailed study of artistic practice presented in this paper we have begun to show how some of these strategies might appear.

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