

Sculpting a Mobile Musical Soundtrack

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ABSTRACT

We present an in-the-wild project to design and study a mobile musical soundtrack that enhances the experience of visiting a sculpture park. As with soundtracks for films and games, the goal was to enhance the emotional and narrative aspects of the experience while remaining in the background. We describe a compositional approach in which we first established a broad musical landscape before treating specific exhibits with detailed musical trajectories. Our study reveals how our soundtrack dramatically shaped visitors' experiences while they remained largely unaware of its operation. We distil seven experiential factors to be addressed by mobile soundtracks alongside ten compositional guidelines.

Author Keywords

Mobile; experiences; soundtracks; composition; trajectories

ACM Classification Keywords

H5.m. Information Interfaces and Presentation (e.g., HCI)

INTRODUCTION

Musical soundtracks are important features of our most powerful media experiences. They are widely used to establish context and drive a viewer's interpretation of narrative and intensify their emotional response. Moreover, soundtracks typically exert their profound influence from a subordinate position, ideally passing by largely unnoticed. This paper explores the composition of *mobile* musical soundtracks intended to accompany and enhance a variety of locative experiences. Unlike traditional media soundtracks, these utilize locative technologies to adapt the music to listeners' movements, which brings them into the realm of HCI.

Our focus on mobile soundtracks is allied to several threads of research within HCI and related fields. Prior research has revealed how people increasingly curate their own soundtracks to accompany everyday activities such as commuting or exercising by creating personalized playlists to socialize, 'aestheticise' and narrate these often mundane, solitary mobile activities [6,19]. Composers have adopted mobility as a driver for creating interactive

contemporary media experiences [4]. There has also been longstanding interest in HCI into how sound in general can guide movement and navigation (e.g., [20,30]).

Our focus here is somewhat different. We are interested in how composers can create meaningful music for mobile experiences where the music assumes a supporting role. What we have in mind are those formal, orchestrated mobile experiences such as cultural visiting, guided tours, and mobile games, which might benefit from having a bespoke soundtrack that reflects the activity and its environment. Consequently, our distinctive focus is to be found in music that is *deliberately composed* for an experience, *enhances emotional and narrative engagement*, and yet *remains in the background*. It is this aspect that we feel is of interest to the field of HCI, the utilization of music to actively drive mobile experiences from a secondary position.

Our goal is to establish a set of principles to guide the composers of such interactive soundtracks, helping them understand how they can subtly enhance mobile experiences and also effectively work with locative technologies, whilst maintaining a rich compositional endeavor. Here, there are two kinds of detail that a composer needs to be aware of: the mapping of music to physical space, and the experiential effects of musical accompaniments within mobile experiences. In this regard, our work builds on that of [17] which reported an experimental study into how various musical structures affected people's exploration of an empty field, proposing initial guidelines on which we extend. This following investigation presents an "in the wild" [12] design-led study in which we created a full musical soundtrack for a specific real-world experience – visiting a major sculpture park – and studied how this was experienced by visitors.

After reviewing related literature, we first describe how we developed a novel approach to composition in this real-world setting. Our subsequent study reveals how the resulting soundtrack dramatically shaped visitors' experience of the park. By reflecting on our findings, we are able to distil an understanding of the experiential factors that need to be accounted for when composing such a soundtrack and also propose specific compositional guidelines. We propose that these guidelines can support the creation of soundtracks for a variety of walking experiences – real or virtual – and thus this represents the value and contribution of this work.

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RELATED WORK – FILM AND GAME SOUNDTRACKS

Our compositional approach draws its inspiration from the wider literature on media soundtracks. As this may be unfamiliar to the CHI audience, we think it is important to briefly review key related work.

Location-based music

Mobility and location are frequent drivers of contemporary music experiences, an area that has consequently witnessed a broad creative and technical exploration [4,15,35,37]. Our work concerns *placed sound* experiences [4,15,37] – normally GPS driven – where users’ entry into, or exit from, geo-located trigger zones initiate playback of layers or segments of sound.

Conventions in soundtracks

Conventionally, film and computer game soundtracks serve a range of functions [5]. Wingstedt describes a set of six self-descriptive classes: *emotive*; *informative*; *descriptive*; *guiding*; *temporal*; and *rhetorical* [36]. Pauli [29] outlines three key relations between music and visual imagery: *Paraphrasing* (the music mimics the visual content), *polarization* (if the visual imagery is vague in meaning, interpretation is drawn from the character of the music) and *counterpoint* (deliberate contrast between the music and visual imagery). Meyer [27] argues, in relation to *polarization*, that music does not denote specific actions, emotions or concepts. Rather, it is the listener who forms these links, often as a result of associations built from historical exposure to other media experiences. *Paraphrasing* and *polarization* can be seen in two typical approaches to soundtrack composition, referred to as *accompaniment* and *foreshadowing* [5]. *Accompaniment*, the music is synchronized with visual events. Whereas, with *foreshadowing*, the music signposts to future events. A well-known example is found in the soundtrack to the film *Jaws*. Composer John Williams utilizes a simple theme to foreshadow the approach of the unseen shark, building tension via the expansion of instrumental layers and a graduated increase in tempo [36].

Musical treatments

We now turn to specific musical treatments employed by soundtracks. Composers of computer game soundtracks use a variety of methods to influence gameplay, such as the presentation of silence at certain locales to subtly encouraging players to move on [11], or the presentation of a salient theme or motif to indicate key events in the gameplay, often referred to as a *stinger* [13]. The latter is similar to the leitmotif – a musical motif or theme that represents a character or concept – a common device used in operas and film soundtracks alike. Lastly, we highlight musical closure, often formed from cadences, as a common device for signifying ‘arrival’ in western tonal music. Through repeated exposure, humans learn to anticipate such closures at key transition points within, or at the conclusion, of compositions [27]. They are also known to aid the interpretation of narrative closure in filmed events [33].

The psychology of film music

Finally, the field of music psychology research has long sought to understand the relationship between music and the perception of visual images. A consensus is held that music does alter viewers’ interpretations of both the associative meaning and emotional context of images [5,8,10,27]. The level of association and congruence that a viewer perceives between music and visual imagery is considered crucial to the formation of a successful soundtrack [5,8,10]. Cohen [10] suggests that when music is temporally congruent with particular visual events, or objects, a viewer’s attention is drawn to these actions. Similarly Chion [8] proposes the notion of *synchronism*, where audio-visual content becomes a single modality, arguing that we “*see/hear*” films, rather than “*see and hear*” them. In addition to the affective and narrative relationships between music and visual images, music has been shown to exert an additive effect, enhancing the enjoyment of visual imagery [8,9].

COMPOSING A MOBILE MUSICAL SOUNDTRACK

In order to explore the challenges of composing *interactive locative* musical soundtracks we undertook a “in the wild” design led research engagement [12] utilizing an emergent HCI methodology – design from within [32] – where the principle researcher, who was also the composer, undertook an iterative process composition and app authoring to create a dynamic soundtrack accompaniment for a real-world cultural experience, before studying how this was experienced by visitors. This holistic approach charts all of the lessons learned throughout the process to develop the compositional principles applied here.

We produced a GPS-driven adaptive musical soundtrack to be listened to on an iPhone and headphones. The soundtrack was implemented using *Calvium AppFurnace*, which enables an author to define physical regions (zones) that start and stop audio files when a user enters or exits them (fig. 1). This technique is broadly typical of current mobile authoring tools and raised important implications for our design, as we discuss below. Pre-composed sections of music were prepared as audio files that contained either individual instrument’s parts or short sections of combined parts, which were then combined and looped to form detailed musical arrangements.

We chose the Yorkshire Sculpture Park (YSP) as our wild setting, a major outdoors cultural attraction in the UK that houses a large collection of sculptures situated in 500 acres of parkland. Our choice was inspired by early visits to the park that reinforced the idea that exploring the sculptures might suit a bespoke musical accompaniment and also that it should be feasible to deliver a reasonable quality experience using current smartphones equipped with GPS. We were also inspired by Fosh *et al*’s prior research where they had designed and studied interactive trajectories through sculptures, including the use of music

(albeit short and non-adaptive fragments of pre-existing, i.e. ‘found’, music) [14]. Our choice of musical style drew on a rich mixture of orchestral and synthesized textures to create what we intended to be an accessible soundtrack – in a nu-classical / electronica style – that we felt would be suitable for the setting and for extended listening.

Figure 1 shows a section of the YSP. The coloured areas represent distinct regions in the park, whereas the white shapes show the location of sculpture exhibits.



Figure 1: A cross-section of the YSP map

The remainder of this section introduces the distinctive approach to composition that we established over the course of the design-led iterative process. An in-depth description is found in [18]. We strongly encourage the reader to refer to the supplementary video material, as well as a fully detailed and musically annotated locale map. The videos display a POV walk-through at the park, alongside a map showing the current location and a description of the structural changes of the music.

Mapping and spotting

We visited the park on multiple occasions to map the location of exhibits, artefacts and existing boundaries and pathways. We also observed visitor behaviour including typical routes through the park and interaction with exhibits. This activity was motivated by that of *spotting* – a film production term that describes a process undertaken by a composer – the identification of scenes to be accompanied with musical cues, along with their style and relationship to the narrative [13]. This led us to develop two specific compositional techniques: *forming a musical landscape* and *composing musical trajectories*.

Forming a musical landscape

By *musical landscape* we refer to and describe the high level musical treatment of the parkland. We felt that distinct areas in the park should be accompanied by exclusive musical cues, similar to scenes from a film. Thus, we mapped out a set of regions in response to existing physical borders, distinct areas of landscaping and placement of exhibits (see fig.1). Each musical cue possessed its own character, created by a combination of unique melodic and rhythmic themes, instrumental

timbres and harmonic key centres. Our map of regions led us to develop a map of musical key centres (see fig. 1 and the supplementary locale map), which enabled us to design for pleasing harmonic modulations on transitions between adjacent regions, motivated by the notion of closure [27,33]. The presentation of silence was utilized as an indicator of the outer boundary of the experience, motivated by the notion of *global attachment* outlined in [17] and the use of silence in computer games [11].

Composing musical trajectories

Given this musical landscape as a backdrop, we next turned our attention to a finer granularity of musical detail. Principally, how to accompany a visitor’s trajectory into and out of interaction with the exhibits situated in the regions, thus a *musical trajectory*. We adapted the approach of [14], which encourages the designers of visiting experiences to consider the following key phases of passing through exhibits: *approaching*, *arrival*, *engagement* and *departure*. In designing musical treatments of each phase, we took motivation from [36] who proposes that music may have *guiding*, *informative*, *descriptive* and *temporal* effects on narrative experiences. Figure 2 illustrates a *musical trajectory*, as experienced in video example 1. First the *AppFurnace* zones are listed; the phases of the trajectory are below; this is followed by the instrument parts presented in each zone; and finally, the character symbols represent the chord progression that flows through the trajectory are presented at the bottom.

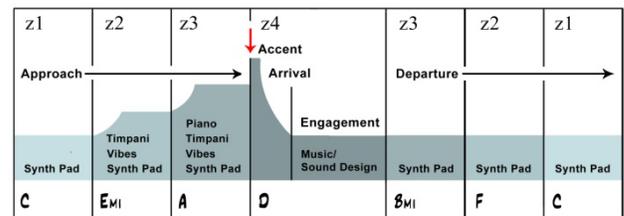


Figure 2: Musical trajectory through an exhibit

- When *approaching* an exhibit we foreshadowed the *arrival* phase (*guiding*) by increasing the musical intensity incrementally; this was achieved via the expansion of musical texture and / or a harmonic progression (see video 1 & 2).
- This intensity is then resolved at the moment of *arrival* (close proximity to an exhibit), which is punctuated by a single musical stinger (*informative*) – a simple take on a leitmotif (see video 1 & 2).
- Our musical treatment for *engagement* actually reduces musical intensity for dramatic effect and to encourage visitors to focus on the exhibits (all videos).
- Finally, we maintain a relatively low musical intensity during *departure* to prepare the visitor for moving on to the next exhibit. The inverse of *approaching* might have seemed appropriate here, but iterative testing revealed this to be incoherent as a sudden increase of intensity after *engagement* interrupted the preparation for the next *approach* phase (see video 1 & 2).

In addition to these general musical treatments, four *engagement* stages were enhanced with specific non-musical sounds, chosen to reflect the particular nature of their exhibits (*descriptive* and *paraphrasing* [29]). Examples included the sound of electricity crackling to accompany a neon sign sculpture (see video 2) or the sound of talking at an exhibit themed around conversation (video 1). These were test cases to observe how non-musical sounds might integrate into the soundtrack.

We hoped that these compositional techniques offered a fitting method to integrate a musical soundtrack into a physical experience. We anticipated that relating changes of core musical attributes (e.g. harmony, melody, timbre) sympathetically to the topology of the space, and visitor movements through it, would enable us to deliver a soundtrack congruent with the experience, thus one placed in the background. Moreover, these techniques also enabled us to compose a rich musical structure on a large-scale and with a broad harmonic, dynamic and timbral palette, thus at a level of detail typically absent from mobile musical experiences. Our final soundtrack covered 21 distinct regions housing 43 exhibits and utilized 102 original musical layers and fragments.

STUDYING OUR MOBILE MUSICAL SOUNDTRACK

We recruited twenty-two participants (11 female - 11 male) to engage in a naturalistic study of our soundtrack in use. Seventeen were aged 40+ years, three were in their twenties and the remaining two participants were aged 10 and 14 years. Three had previously visited YSP, two being regular visitors. Four happened to be trained musicians: two regular performers and two who teach music at primary school level. All participants were invited to attend the park for the purposes of the study.

We requested that they explore the site while listening to our soundtrack throughout, with removal of headphones denoting the end of the experience. No set duration was imposed although 10–90 minutes was suggested as a guide. We felt it was important to let them experience the soundtrack on their own terms, in as natural a way as possible given the constraints of research. Thus, we did not give a technical briefing about the system's dynamic functionality. All began at the same location.

Post-study interviews recorded onto a Dictaphone captured the participants' opinions of the experience. They were invited to talk freely about anything of interest and questions were posed only when required to guide the discussion and to explore various aspects of the experience, such as: what they were thinking of during the walk; appreciation of the music; routes taken; and the rationale for any key behaviors. A map of the YSP with images of the sculptures enabled participants to highlight specific exhibits during the interviews. The interviews were then transcribed from which recurring or interesting themes were highlighted.

Findings

We offer a brief overview of our data before focusing on key issues that emerged from the interviews. Visitors spent on average just over an hour walking and exploring the park, covering an average distance of 2.77km. The overwhelming majority of participants (21) described it as an enjoyable experience. Typical comments were, "*Very enjoyable*", "*just lovely, lovely experience walking around*" and "*I've got this beautiful music going on, which enhanced the whole experience*". Many felt that the soundtrack blended into the YSP experience, rather than functioning as a separate layer of modality, "*the whole thing seemed an experience, the music, the sculptures, where I was, everything it all seemed to be part of that experience*" (P3). However, two had some difficulty in navigating the park, which seemed to restrict the area they covered, while five experienced some technical malfunctions. Two of these were unaware of the fault – a musical fragment, which should have stopped, continued to play – but rather than disrupting their experience this appeared to extend their walk, as they continued on while the music sounded. The other three did suffer from disruption as a result of technical malfunction. The majority covered a large proportion of the soundtrack area, approaching an average of 31 exhibits each.

General reflections on the music

The vast majority of participants spoke very positively about the music, with only one expressing a dislike for it. Generally, terms such as *beautiful*, *relaxed*, *calm* and *emotional*, but also 'samey' and *non-specific* were used to describe the music. The music was largely considered appropriate for the nature of the YSP experience. None of the participants reported any listening fatigue, although two suggested they might have stopped listening sooner had they not been taking part in the study. Prior to the walks, the investigator observed a tendency for participants to remark about the size of the headphones, or to pull a face that expressed uncertainty or embarrassment about wearing them. However, this unease was not present upon the conclusion of their walks: "*I was quite surprised that I didn't feel as self-conscious as I would normally do*". When asked if being isolated from the ambient sound made them feel vulnerable, P3 stated, "*No, not at all. I suppose it wasn't like being on busy road or street or anything, but still there are people around you*".

Being unaware of the operation of the soundtrack

Notably, the majority of the participants seemed unaware of the dynamic functionality of the soundtrack and some comments implied a presumption that it was a fixed linear recording: "*Like in the bit where there were more coloured sculptures you think has this been set intentionally [changes in the music], but then not every person is going to take the same route, so you can't say that*" (P14). This participant was describing the music matching an exhibit as though it was intentional, but they could not understand how this could be achieved. Only

four participants presumed that GPS playback functionality was being used (P7,11,19,20). P11 described testing out this assumption on the boundary between two regions and following their realisation they speculated that it enhanced their appreciation of the soundtrack and the experience further. P8 (aged 14) also described testing out an arrival zone boundary at an exhibit, which contained sound design elements (see video 2). Following this account, P8 went on to state that they then proceeded to look out for other musical changes around exhibits; noting that sometimes they thought there was, but other times they could not tell.

While many appeared unaware of the adaptive nature of the music, some did describe synchronisation between the music and the wider world of the park: *“The whole experience of walking round is complete with change. Change in scenery, change in sculptures and the music seemed to reflect that quite well”* (P7) and *“You might enter a new bit and there is an evocative bit of music that goes with it and that has a bit of a ‘ooh’ feeling to it”* (P11). These quotes are suggestive of transitions between physical regions accompanied by new musical cues.

The stingers placed at points of arrival were less successful. Although noted and reported by eight participants, six of these thought they were either random musical events that were musically out of place, or felt that they signified something, but were unsure what. The remaining two identified these accent occurrences around the location of the sculptures, interpreting this to mean that they should pay attention to the local area, *“It seemed to be when I got to a more different type of sculpture, whether it was coincidence or not ... there was like a ping in the music, you’d got to look at it more carefully, look at the sculpture more carefully ... just remind yourself to look at something more intensely”* (P12).

In contrast, the four exhibits featuring impressionistic sound elements during the engagement phase were referred to positively by 6 participants. *“There was like a colourful Buddha. (laughs)...I think you were planning it, you got some remote control that changes the music! The music went on just one note, like a drone and I just felt really peaceful, as if he was doing his “oommm”. And I just felt like I wanted to stop there”*.

Having discussed the music at length, we now turn to how this music impacted on the wider experience.

Walking alone on a winter’s day

The study was undertaken during the winter months and the weather was predominately cold and wet. Furthermore, the grass was especially muddy in those well-trodden areas surrounding the exhibits. Eight participants noted, with surprise, how unyielding they were to these conditions, citing the musical accompaniment as the reason: *“I noticed lots of other people walking back because it was raining and I didn’t*

actually feel the need to hurry” (P1), and *“My fingers got quite cold ... normally I would look at the weather I think, “oh I’ll call it a day”, but no, the music, it made me feel so relaxed I just pulled my hood up and carried on”* (P3).

Eleven participants suggested the music affected their walking behaviour. Seven speculated that the music slowed down their pace, which reflects the prevalence of slow tempi throughout. In contrast, four participants singled out a particular region for discussion. This region’s music was highly syncopated and at a moderately fast tempo (in comparison to the others) (see video 3). As one participant noted, *“the music was obviously getting quicker anyway, so you almost felt like you could skip through that bit”* (P14). Two participants stated that they, on occasion, felt a pull to synchronise their walking pace to the music’s tempo, with one expressing frustration that the pulse of the music was ever so slight too slow, but nonetheless they adapted their walking pace to match it.

Although all participants undertook the study independently, many arrived at the YSP with family or friends. Ten participants made reference to this lone experience, as it was unusual for them to engage in this type of activity unaccompanied. Some mentioned they would not have walked as long if there had been without the music, whereas others were surprised at how much they enjoyed the solitary experience. Some went on to suggest that the music defused potential feelings of self-consciousness and isolation, for instance, *“I don’t think I would have been as relaxed if I hadn’t been listening to the music, especially walking round on my own”* (P3).

An enhanced emotional experience

Some commented on how the soundtrack changed the nature of the experience, typically enhancing it: *“The overwhelming thing for me was how it made it a different experience, I am so shocked, really, really shocked because it made it more than just being a visual thing ... It was almost like going to a show ... it was an experience that I would do again because I ended up having a different take on my usual visit to Yorkshire Sculpture Park”* (P10). Participant 10 has been a frequent YSP visitor for over 25 years, who also attended college at the site. Others noted how the inclusion of the soundtrack made the exhibits more engaging and enjoyable, for instance a couple reported how the music made the sculptures seem more special, even those they did not like, whereas one illustrated that the soundtrack made for a more accessible experience, *“Normally I wouldn’t come to somewhere like this because I don’t get a lot of where they are coming from (artists) and if you don’t understand something it doesn’t really float your boat, but in actual fact today wandering around on my own, I really, really enjoyed it and that must be to do with the music because the sculptures are just the same aren’t they?”* (P15).

For some, this general enhancement of the sculptures spilled over into an aroused emotional state: *“I do think I*

have been through a range of emotions today” (P15). Two participants highlighted how the combination of sculptures and music in a particular region created a dark and uncomfortable mood, which resulted in them wanting to leave that area: *“Sometimes it was very relative to ... how it made me feel mood wise as well ... there is one of the three men with the white faces ... walking up there looking at those ... the music became a little bit darker and it sort of made me want to move on from there”* (P6). *“There is one section where the music was quite foreboding, and it actually quite spooked me, that combined with the figures ... I’ve never had that kind of experience before and it got to the point where I was thinking ‘I really need to get away”* (P20). Returning again to P10 (historical connection with YSP), they encountered an intense emotional reaction to the soundtrack experience, *“so immediately I put the music on and I started walking out, well I was in floods of tears because it just brought everything back, but I think it heightened it because it was the very moody music and I think it made that even more strong”*. The strength of their emotional reaction is intriguing, notwithstanding their history. The participant later implied that this type reaction was not typical of their visits to the YSP.

Focusing on the sculptures

We asked the participants where their focus of attention was during their walks. Twenty of the participants reported that their attention was firmly placed on the exhibits and parkland, *“When you look at the statues you tend to concentrate on the statues and the music just blends into the background”* (P5). Only P7, on occasion, felt that selections of particularly melodic music drew their attention away from the visual stimuli. Seventeen participants reported that the music encouraged them to view the exhibits, parkland and other artefacts with a greater intensity and for a longer duration than they would normally experience: *“It made you concentrate more on what you were looking at than if you had done it without it”* (P2); *“I’d stop and think a little bit more, probably study a bit more”* (P6); *“I think there were times when I felt the music made me more observant”* (P10). In these quotes, participants suggest that the music promoted an intense level of focus.

Others in contrast, suggested that the soundtrack masked external sound and so reduced distractions: *“Having the music on I felt cocooned and I could shut everybody else out and concentrate on what I was doing”* (P3); *“It just tended to focus my concentration more, because I had no distractions apart than what was in front of me”* (P5). Alternatively, five participants felt that the soundtrack masked their inner thoughts and dialogue, for example: *“What I was surprised about was that I’d got so much time on my own ... I thought it would make me think of work, things at home and it didn’t. I didn’t really have any thoughts about me at all”* (P15).

Making connections

Although participants were largely unaware of the operation of the musical soundtrack, as discussed earlier, they did note powerful, apparently serendipitous, moments when they were able to make connections between the music and the sculptures or parkland. Some of these were quite general: *“walking around sometimes it [music] was very relative to what I was listening to as to what I was looking at”* (P6). Others, however, were more detailed, such as the formation of connections between the colour intensity of the exhibits and changes of intensity in the music, *“I certainly liked the Buddha and the octopus, the bright ones mainly ... whether that was because some of the sculptures were blending in with the landscape, you know the lighter ones seemed to be a bit more dynamic [music]”* (P12), and *“there was this moment at the beginning where we were standing in the middle of ... a group of sculptures and the wind came past and blew all these yellow leaves past and the music was really atmospheric and it was just really beautiful”*.

P10 presented several very specific examples, such as connecting the melodic and rhythmic contour of a xylophone ostinato figure in a musical episode with ripple patterns they were watching on the park’s lake, *“There was a tree with the light coming through from behind that was reflected onto the water, it was making the most beautiful patterns. Just at that point a xylophone was doing that repeated pattern ... if it hadn’t got the xylophone pattern sort of rippling away, repeating and rippling, and the reflections on the water were very uniformed as well and I just thought ‘ooh, ooh’, that was a new experience anyway”*. P10 stressed that they did not intentionally seek out these connections, *“I feel sure I wasn’t looking for it, it was just there”*.

DISCUSSION – EXPERIENCE AND COMPOSITION

Overall, we propose that these findings reveal our soundtrack to have provided an effective underscore for this experience. The tenor of participants’ comments is that the music contributed to a distinctive experience, one in which they spent considerable time isolated, slowly moving among the sculptures, even in inclement weather, and where the music tended to focus attention on the sculptures, heighten emotional arousal and occasionally provoke moments of serendipitous reflection. And yet, the music also maintained for the most part a background role. Stylistically it integrated with the activity while technically the system mostly delivered a glitch free soundtrack, which left the majority unaware of its dynamic operation. In short, our soundtrack appears to have contributed to a cohesive, if somewhat unusual, experience while remaining in the background. Our discussion now reflects on why the experience worked as it did, drawing out lessons for practitioners and researchers. We address two broad themes: key experiential factors and compositional guidelines.

Seven experiential factors

The transcripts reveals a rich range of experiential factors that explain the distinctive qualities of our soundtrack experience. For the benefit of this discussion we address these individually referring to a broad body of literature that have had similar observations but in different settings and with different music. This enables us, with some degree of confidence to describe these factors in general terms rather than them being exclusively associated to the specific music composed for this soundtrack.

Abatement

The reported tendency for slow movement can be explained in terms of the principle of abatement. Prior research has demonstrated that humans will synchronize physical actions and movements to the tempo of music [31] and has correlated people's preferences for musical tempi with their levels of physical activity [22]. For instance, slow tempi are preferred for minimal to moderate intensity of activity. In our case the slow tempi may have encouraged an abatement of walking pace.

Accompanied solitude

Participants stressed how unusual it was for them to engage in such an activity alone, but then discussed this lone experience in a positive manner, suggesting that the music, transmitted via headphones, was the primary factor in the formation of a deeper engagement with the park and its sculptures. None expressed feeling self-conscious. This appears to mirror a stream of prior research on everyday mobile music listening [6,19], which emphasizes its *dissociative* function in which people immerse themselves in personalised 'soundworlds', experiencing feelings of accompanied isolation, control, self-sufficiency, an even a form of sanctuary [6].

Comfort

Participants also described a sense of detachment or comfort in the face of unpleasant weather conditions. Music has long been recognised – in the field of music therapy – for its ability to relieve pain and discomfort, whilst promoting feelings of relaxation [23,26]. Much of this work argues that stimulation of the auditory system, from listening to music, distracts attention from the body's pain sensors, and also that fast acting emotional responses to musical stimuli "*chill and thrill*" [23:152]. In our case, the musical style and timbres used, along with the largely slow tempi appears to have promoted *chill*.

Emotional enhancement

Beyond comfort, it appears that the musical soundtrack stimulated an emotional response to the YSP. Music has an historical relationship with human emotions, although the nature of this relationship remains contested [24]. A prior example of research on music's effect on emotional responses concluded that viewing pictures whilst listening to classical musical provoked strong emotional responses [3], whereas another study, which focused on human's responses to musical listening in relation to their context

and setting, revealed that music listening in solitary settings led to feelings of "*calm-contentment, nostalgia-longing, and sadness-melancholy*" [21:678], both of these examples broadly reflect our experience. The additive effect that music exerts on the interpretation of visual imagery, in our case sculptures, has been accounted for in terms of *spreading activation* [9], the notion that a mood or feeling conjured from the music spreads over to any visual element experienced concurrently. Similar is Chion's concept of *conceptual resonance*, a cyclical process in which music affects a viewer's interpretation of an image, which in turn affects their impression of the music [8]. Shifting to mobile music listening, Bull and Herbert present *spreading activation* to account for how iPod's 'aestheticise' their environment and in doing so improve the quality of their experience [6,19].

Increased focus

Participants reported that the music led them to focus more intently on the sculptures for longer durations than they might have otherwise. Some speculated this was due the masking of ambient noise or being free from normal social interactions, which cause distractions. This reflects Bull's [6] assertion that personal stereo listeners often control their surroundings by blocking external sound. Some visitors also reported a distraction from internal 'chatter', which is similarly reflected by Bull [6] and Herbert [19:51], who proposes the "*reduction of intensity of thought or internal dialogue*" as a primary impact that music has on humans everyday lives. Other research suggests that the music in itself may create a state of increased attention. For instance, a study of young males showed that memory and attention were enhanced whilst listening to music while their susceptibility to external distractions was reduced [28]. The core principle appears to deem that music listening initiates arousal, which then increases a listener's facility for cognitive processing, thus enhancing their attention [9]. Our 'focusing' effect is probably a combination of audio masking, solitude and musically initiated cognitive processing.

Serendipity

Some participants were open to forming connections between musical and visual events, leading to engaging serendipitous encounters. Various working definitions for serendipity have been documented including Austin who describes *happy accidents* arising from apparently unconnected events [2] and Liestman who highlights the importance of *synchronicity* [25]. Both resonate with the examples reported by our participants, including chance connections discovered along the way that were not planned by ourselves (e.g., connections between melodic ripples in the music and ripples in the water); as well as responses to our deliberately orchestrated features of the soundtrack (e.g., the sound design at the Buddha exhibit). Interestingly, moments of serendipity still occurred for the few participants who recognised the dynamic functionality of the soundtrack; presumably, as the

location of musical changes and their relationship to the environment were still unknown in advance.

Congruence

For the most part, visitors considered their experiences to have been cohesive, rather than unrelated combinations of audio-visual-physical stimuli. Indeed, the majority did not even recognize the automated nature of the soundtrack. This striking finding can be explained through the concepts of *audio-visual association* and *congruence*. Several documented approaches describe the need for both temporal congruence and semantic association between music and imagery when creating audio-visual experiences that avoid distraction and divergent modalities. Two examples are Cohen's *Congruence Associationist Model (CAM)*, [5,9,10] and Chion's *Synchresis* [8]. The large majority of our visitors considered the music appropriate, thus associated to the sculpture park, while attention was principally focused on the visual artefacts (broadly reflecting the *CAM*). That the majority did not consciously perceive the soundtrack's structural design could offer two conflicting readings: first, the music was sufficiently nondescript; second, the structure of the music was effectively associated and congruent with the structure of the park, and as such the soundtrack was not a divergent modality.

We suggest that the combination of these seven experiential factors explains the distinctive nature of this experience. Recognising these factors also raises strategies that other composers might follow to create similar experiences. First, choice of tempo is not only a musical matter, but may be used to consciously shape the pace of walking and hence of the experience as a whole, in our case slowing it down. Second, appropriate music delivered through headphones can create a particular kind of solitary visiting experience, which is comforting and can increase focus on exhibits, and may stimulate strong emotional responses. Third, with careful choice of style and alignment of its structure to that of the wider experience, composers can create congruent soundtracks in which the music soundtrack fades into the background to play a supporting role and even foster serendipity.

Some of these implications stand in contrast to previous research on interaction in museums and galleries that has emphasised the importance of supporting group visiting [34], highlighted the challenges of wearing headphones [1] and focused on the importance of collaborative displays [16]. Our experience suggests an alternative strategy, one of isolation leading to deep engagement. Not that we are suggesting that all experiences should be of this form. We recognize that many visitors seek sociable experiences. However, we suggest that isolated experiences may provide a powerful alternative for others.

Compositional guidelines

Having reflected on the broad experiential qualities of our soundtrack, we now turn back to its underlying design,

revisiting our two compositional methods of a musical landscape and trajectories outlined earlier to distil a final set of compositional guidelines for mobile soundtracks. The "in the field" design led process has notably built upon and driven forward those emerging compositional techniques developed in [17], as detailed in the following.

Guidelines for musical landscapes

Our first set of guidelines address establishing the overall musical landscape within which the experience will take place. The challenge here is to create a congruent mapping between contents and layout of the environment, and thematic and harmonic structure of the music.

Define a global boundary. An explicit musical boundary should surround the area(s) of the intended experience reflecting Hazzard *et al's* notion of *global attachment* [17]. We propose a two-layered boundary mechanism in which crossing this boundary might first be indicated by reducing the music to a background sound (a low drone in our case) and subsequently fading to silence beyond this (as several of our visitors continued to follow our drone without realizing they had crossed our global boundary).

Establish regional attachment. The overall composition can be structured around multiple regions of the physical environment that mark new areas, sub-divide larger areas, or contain artefacts of interest. Composers should encourage *regional attachment* [17] by associating each region with a different, but complementary tonal key centre and distinct timbres that contrast adjacent regions.

Compose musical transitions between regions. Harmonic modulations are recommended as coherent and effective signifiers of transitions between adjacent regions. Closely associated regions may share a common key centre and instrumentation, but achieve distinction through subtle variations to thematic and textural content.

Do not choose paths as boundaries. Although pathways appear to define natural boundaries in the physical world, composers should avoid using them as musical boundaries, as people who walk along them will tend to repeatedly retrigger modulations and musical transitions.

Guidelines for musical trajectories

The next step is to compose musical trajectories across this landscape, especially into and through key points of interest. Here we extend Fosh *et al's* proposals for authoring trajectories through gallery and museum exhibits in terms the five key stages of '*approach, engage, experience, disengage, and leave*' [14], proposing that composers might adopt different musical strategies at different points along such a trajectory.

Increase intensity on approaches. Musical contours such as expanding pitch registers, layers of texture and chord progressions may foreshadow arrival at a point of interest [5]. Where chord progressions are used, the tonic chord of the region's key should be established in the

outer zone of a region before the chords advance through approach zones. Added layers of instrumentation may also contain increased rhythmic content (i.e. sequences with shorter note values) to further intensify the level of textural density (see Fig. 2).

Mark arrivals. *Arrivals* may be signified by concluding any *approach* phase by climaxing and dissipating the dynamic contour, for example through harmonic resolution – via a return to the tonic chord of the region’s key centre, or by way of a modulation to a new key. The addition of a musical accent or motif that signifies arrival at a specific point of interest [18] (Fig. 2) was less successful here and warrants further investigation.

Make room for engagement. Based on our experience, we suggest that the music to accompany people’s *engagements* with points of interest after *arrival* should, in contrast, maintain a low dynamic level for two reasons, both of which aim to avoid interference with the wider experience. First, to shift the participant’s focus towards an artifact; this might be a dramatic moment as the music fades to the background as they are confronted with an object and become more aware of the surrounding world. Second, to make space for more ‘paraphrased’ treatments of an artifact, for example the introduction of highly associated sounds or even a spoken word commentary.

Treat departures distinctly.

Perhaps our most unusual proposal concerns the treatment of departures from a point of interest. Here, we argue that the dynamic level of the music should stay broadly consistent with the dynamic level experienced during the *engagement* phase, rather than mirroring the *approach* music but in reverse. Some variation to the music may be desirable at this point – to present a different scene on the way out - but the music should retain the character of the region. Thus the overall musical progress through a point of interest is asymmetric, increasing in intensity on the *approach* but then dropping away during engagement and maintaining a lower level during departure (see Fig. 2).

As a final note on this topic, our experience suggests that it may be useful to begin the whole musical composition with an initial pre-canned introductory that gracefully leads the participant into the main adaptive soundtrack.

Composing for the seams in technology

Studies of location-based experiences have concluded that designers need to accommodate so-called seams in the technical infrastructure, those technical glitches caused by the unavailability or lack of precision in positioning services, wireless communications and other technologies [7]. We offer two guidelines here.

Compose for uncertain positioning. First, it is necessary to undertake detailed mapping of the setting to identify potential troublespots. Areas of high uncertainty require a coarser treatment, for example through larger zones.

There should also be appropriate default music to be played when the positioning system is unavailable.

Compose for uncertain synchronization. Current location-based platforms tend to support simple discrete location triggers with little control over the fine-grained synchronization of digital media. It can, therefore, be very challenging to achieve tightly synchronized transitions between musical fragments to the level that composers might normally expect from music software. To minimize musical ‘glitches’, composers may wish to avoid using prominent, tightly-structured themes in favour of ambient, slowly evolving themes upon static harmonies and textures that can be easily entered and exited at any point.

CONCLUSION

We have shown how it is possible to employ current locative technologies to create a rich interactive musical soundtrack that enhances the visiting experience. Our research suggests various strategies for composers and designers, including being aware of the key experiential impacts of music, as well as guidelines for composing musical topographies and trajectories through these. It is of course necessary to recognise that the arguments in this paper are based on one example. Future research needs to explore how our findings might transfer to other settings, but the potential scope is broad: musical soundtracks of this type could accompany a whole host of walking based activities from the type described here to our daily commutes. Application in internal settings such as exhibitions and galleries is also intriguing. Especially promising in our view is the potential for use in computer games, a major market for digital technologies that routinely employs soundtracks and where there is an increasing focus on (virtual) location-based experiences. Longer-term adaptations of our guidelines might extend to dynamic music on other forms of transportation such as cars and public transport. We also see controlled studies as a possible route forward for focusing our research. We need to reiterate that we do not see such experiences as replacing other kinds of engagements, especially those that are sociable, but rather that they might form a new part of the ‘armoury’ for experience designers. This said we hope that our experience raises new challenges for future research.

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