

DIGITOPIA: An Interactive Experience to Accompany a Dance Performance for Families

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ABSTRACT: The Digitopia interactive combines on-screen graphics and musical arrangements. Deployed on eight tablet computers, it was designed to accompany a touring dance performance for young audiences. Available to use in the theatre foyers before and after the show, families collaboratively created graphics arrangements and soundscapes that were directly inspired by the dance performance. Our evaluation results detail how both children and adults used the interactive and how the design dealt with variable foyer layouts and locations. We then discuss the ways in which the Digitopia interactive allowed for a spatial and temporal extension of the dance performance and how it enabled families to more deeply engage with the concepts of that performance.

1. INTRODUCTION

The development of young audiences has seen increased interest in recent times, both in theatre [1] and now also in dance [2]. One key reason to work in this space is to develop young people's cultural capital and therefore future audience participation. However, preventing its traditional marginalisation in comparison to adult theatres requires that the needs of young audiences are considered seriously; that they are seen as present audiences, rather than future ones [3]. In this broad context, we were approached by a local dance company who had been commissioned to produce a dance piece for audiences between 5 and 10 years old and their families. The piece presents two characters embedded in a fantastical world of graphics and sound, who create increasingly complex shapes and soundscapes from the two core geometrical components of points and lines. This was realised through an intriguing mix of physical and digital scenery elements, which evolve during the show. Over a two-month period, the piece was performed at 16 UK venues. Audiences positively received the dance performance and it found critical acclaim. While not the focus of this paper, the dance performance provides the context for the development of the Digitopia Interactive.



Figure 1 Still from the Digitopia Stage Show – Copyright Tom Dale Dance

The dance company approached us to collaborate in the design, development and deployment of a digital interactive twin experience to tour alongside the stage performance. This being an 'industry-led' project, the direction and context for the work were provided by the dance company and in discussions with them the following aims crystallised.

Aim 1 - Extend audience engagement beyond the stage to the foyer: The company wanted families to have an extended engagement with the piece before and after their time in the theatre auditorium. Traditional theatre foyers, in their view, should be more open and

accessible to communities in general and should form part of the performative experience.

Aim 2 - Improve conceptual engagement: To engage children and families in a more practical exploration of the relationships of geometry, interactivity and music, rather than being limited to watching this relationship on stage.

In addition to these experiential aims, there were also a number of practical constraints that were raised by the funder of the tour of the Digitopia dance show. The interactive twin had to be deployable in a variety of different theatre foyers that could not be specified at the outset. Thus the experience needed to be suitable for a range of theatre foyer configurations, appropriate for a broad age range (from 5-10 years old), and be able to withstand a throughput of 150-200 audience members per performance at around 15 venues.

In response to these aims and constraints we produced an interactive experience to run on 8 tablet computers housed in a portable construction for deployment in theatre foyers. We now discuss the background to this work before moving onto describing the design process, which occurred alongside the design process of the Digitopia Dance show itself.

2. BACKGROUND

2.1 ENGAGING YOUNG AUDIENCES

Engaging young audiences to appreciate performance as an activity in general and beyond the time of the show in particular remains a challenge. Prepared study guides, guided drawings, and structured discussions of theatre [3] as well as arts and crafts activities have been introduced to engage children in movement and choreographic development [2]. Warhorse for example, the popular children's production, offers puppet making workshops, [4]. TPG involved audiences in the set-up and take down of the theatre production [5. P.11] and 'No-Body' integrated normally non-accessible parts of the theatre building [6]. An ideal situation arises when audiences are prepared before the show *and* follow-up activities are conducted [2].

Digital elements have increasingly featured on stage in theatre and dance [7]. A key reason for this is the wide availability of the required

technology, for example via the Isadora tool [8]. Dedicated dance companies, such as IJAD [9] and Compagnia TPO [10], develop work in this space, and the 14 Pixel performance [11] demonstrates how far the combination of digital graphics and dance has come. However, there appear to be only few examples where extended engagement with stage performances and digital interaction are combined in performances for young audiences. Brain opera involved audiences in the production of sounds on digital instruments that were then re-used on stage [12] [13]. The White app is designed to engage children with the concepts of the White show, without replicating the performance [14].

2.2 AV REPRESENTATIONS

Using visual shapes to represent musical objects has a long history in composition and performance. One example can be found in the graphic scores of 20th century composers, where traditional music notation was not appropriate to represent indeterminate compositions [15]. FMOL [16] is a graphical interface for the creation of sound synthesis, where musicians can 'pluck' or 'fret' the vertical lines at different points and it visually oscillates to illustrate its sound behaviour. Other approaches have for example mapped the strokes found in Chinese calligraphy to pitch, duration and timbre [17]. Systems aimed at children and young people have explored mapping drawing (e.g. mouse, touchscreen, smart-board) to music. For instance, Hyperscore, [18] [19] and Vuzik [20] employ a 'Piano roll' representation of music (pitch placed vertically and note durations horizontally). Users draw coloured lines that define the melodic and rhythmic motifs. These examples all use some similar design elements, which we drew motivation from, namely simple shapes, separate shapes to represent each single musical element, and the use of spatial metaphors, e.g., changing musical elements along vertical and horizontal axis.

3. DIGITOPA INTERACTIVE

We now describe the design of the Digitopia Interactive: an installation consisting of 8 tablets housed in two cases that enables users to create graphical and corresponding musical patterns by dragging simple graphical elements on a touch-screen. These mirror the visual and audio concepts contained within the accompanying dance performance.

The Interactive was developed during a rapid 10-week iterative design process in parallel with the dance show's development and rehearsal process. We drew on the key design elements of the dance show as they emerged: lines, dots and music fragments composed by the show's resident composer. It is important to emphasise that design elements of the dance show only emerged during the design process and associated rehearsals. The rapid nature of the process and required responsiveness to change meant that there was no time to test different options with our target audience, while technical, expert testing was done in-house throughout. The Digitopia Interactive then premiered with the Digitopia dance show, which kept evolving beyond its premiere.

3.1 FIRST SKETCH

A first sketch developed in week three of the project already exhibited the key elements of the final experience, all in turn inspired by the emerging details of the stage show developing in parallel. This included the idea that the experience would be deployed on tablets, possibly embedded into freestanding plinths that have either an integrated speaker or a set of headphones. Each player would be able to select lines from a limited pool and connect them up to create specific sets of shapes, with lines for example snapping to each other at 60 degree angles.

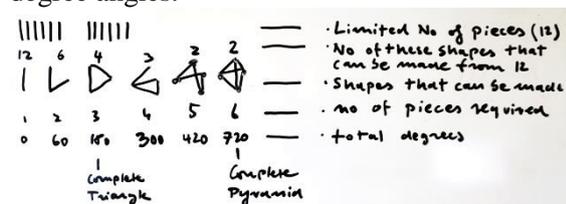


Figure 2 Initial ideas to combine graphics and musical composition

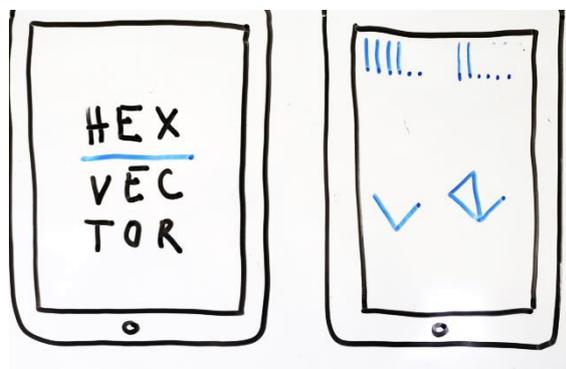


Figure 3 Sketch of how this design might appear on the tablet computers including its working title Hex Vector

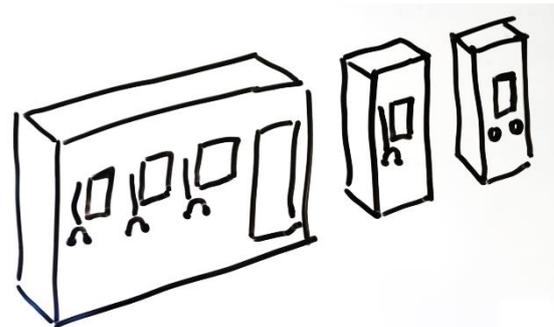


Figure 4 Sketch of physical presentation of the tablets in multiple cases, later discarded as too bulky to transport and too limiting in terms of players heights

At this time we thought about how the created shapes might link to a number of variables, which would in turn link into a generative musical score inspired by the stage show. Multiple tablets could then be used together to create a single, overarching soundtrack.

3.2 DESIGN ITERATIONS

As a first step, the visual concept was transferred into a digital graphics package to start evaluating the interaction design and look and feel more closely. Figure 5 shows how the design progressed to include a set number of lines at the bottom, out of which constrained shapes would be assembled. The idea was still that lines would snap together in a 3D representation to form pyramids: at this point, we had observed that pyramids were a prominent "on-stage" feature in the Digitopia dance show rehearsals, and we were keen to create strong visual links between the stage performance and the on-screen experience.

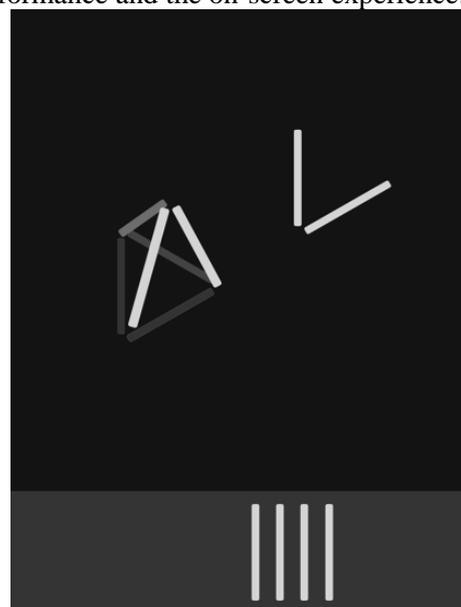


Figure 5 Iteration one with two pyramids to be covered in musical elements.

The link between graphics and sound became our focus during the next phase. Initially, we looked towards prior research into musical and topological relationships. This led us to the Tonnetz, a conceptual visualization for the relationship of notes and harmonies within traditional western tonal music that is shaped like a lattice [21]. The parallels between this and the Digitopia pyramid shape were clear and intriguing. At first we considered a scenario where each line of the pyramid shape on the Digitopia user interface would represent a single note of a chord, thus when combined, the full sonority of the chord would sound. Another option on this theme considered the addition of each line enacting a change of chord harmony, using the relationships as set out in the Tonnetz.

These initial ideas concerned the construction of musical harmonies and while they reflected the notion of the Tonnetz well they did not address how the music could unfold rhythmically, meaning that if each note (line) just sounded a continuous tone, the musical content would quickly become monotonous. At this point we decided to seek inspiration and guidance from the Digitopia performance soundtrack, which was developing in parallel to the dance performance and the interactive twin. From this point onwards, we worked on developing an approach where each visual line of the pyramid represented a different musical element (instrument) that when combined formed a single detailed musical arrangement. Whilst this drew us away from the strict relationships of the Tonnetz, its inspiration remained in that these musical elements were typically constructed around complementary harmonic content.

Our discussions led to a second major iteration, which included more constraints but also added control over the quality of the sound, once a harmony was assembled.

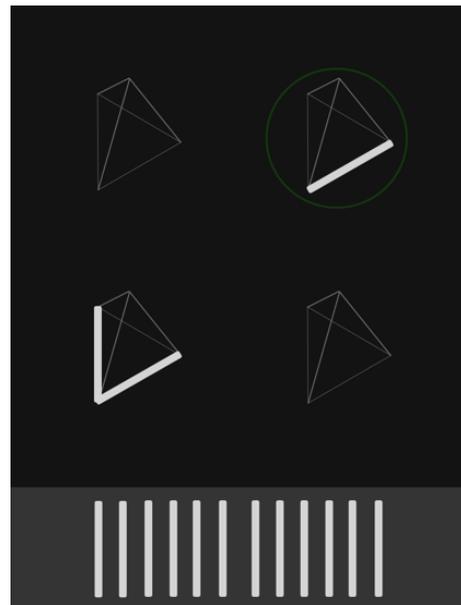


Figure 6 Iteration 2 adding 'scaffolding' background shapes to indicate the interactivity and a mechanism to distort the assembled sound

As Figure 6 illustrates, we concentrated on providing some geometrical guides in pyramid form. This was so that we did not have to explain the possible interaction too much. An effect wheel was also added, which we thought would be used to change effects in a two-dimensional effect space. Returning to the relationship with the musical score, it became clear however, how having multiple shapes to be “dressed up” would lead to a lot of complexity. Given that there would be up to 10 experiences running at the same time in the same room, we discussed at length how to best avoid an unpleasant cacophony emerging. We decided to simplify our concept, leading to the next prototype offering only one shape as shown in Figure 7. This design also reflected for the first time the two characters of the show. The design and concept of the Digitopia stage performance had developed to include two characters, namely Dotty and Hex, played by the two dancers on stage, which we now represented by dots and lines.

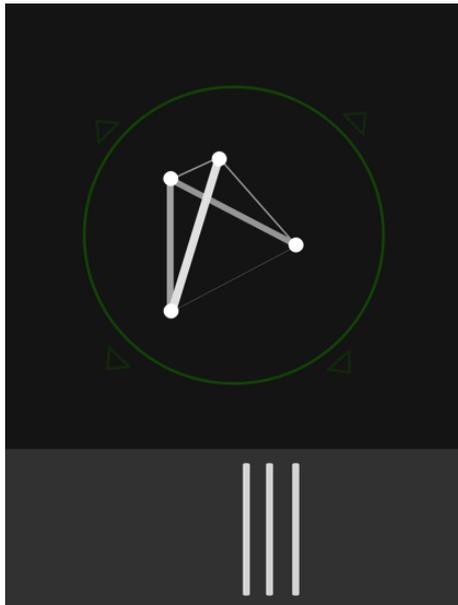


Figure 7 Iteration 3 focusing on a single shape and effect controller

We retained the idea that the user would move lines on to the canvas, and then link up the four dots to create a single pyramid, with the soundscape building up as the interaction progressed. The effect wheel now clearly indicated a direction of travel, hopefully prompting people to pull it that way.

We then returned to the music, specifically how best to address multiple tablets broadcasting publicly at the same time in a given space. The dance company preferred the experience to work through speakers so that sound could fill the room (we also provided headphones for venues that would not accept this). We turned our attention to how we could make multiple different instances of our musical arrangement that could be played on each of the tablets. This represented a challenge, as the music broadcast from each tablet would combine with that of the other tablets sounding in close proximity, thus these variations needed to work together musically. We took a simple approach to this by having the same music playing on each tablet – melody and rhythms – but using different sounds to present the six different musical elements. As a result each tablet broadcast a unique variation of the same music. We created six different MIDI files. Each MIDI contained a complete arrangement for a tablet, with each of the six musical elements mapped to a different MIDI channel. MIDI channels permit for individual control over musical

themes within a complete arrangement, such as volume, pan, and mute.

3.3 FINAL DESIGN

The final Interactive design was implemented as a standalone web-app in HTML5 using the 2D game library Phaser and CSS to style elements. Music was played using the midi.js library. The web-app was hosted on 8 tablets, each connected to an external speaker.

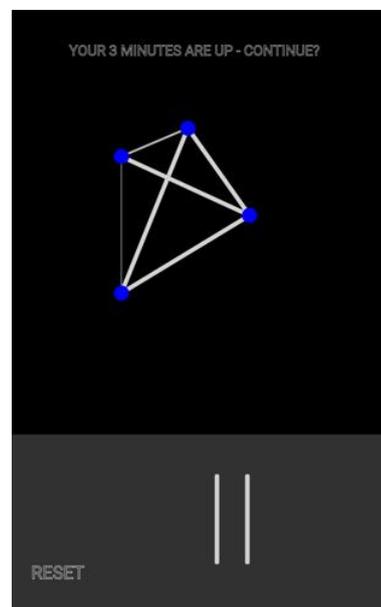
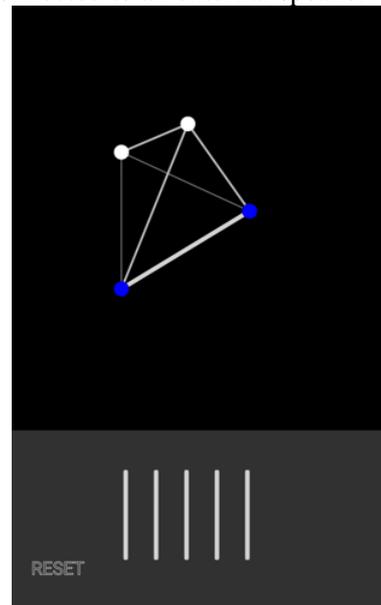


Figure 8 Final deployed iteration 5: One line placed, playing single track of music score (top); four lines placed, playing four tracks of music and time out warning (bottom)

In the final iteration of the app, lines can be dragged one-by-one (in any order) on the screen to ‘dress-up’ a pyramid’s outline. For each line placed, one track of the music plays,

building up to a six-track music score reminiscent of the music heard in the Digitopia stage performance. The sounds used were varied slightly for each of the eight deployed tablets. The blue dots at the extremities of lines can be dragged across the screen. This distorts both the pyramid (stretching the shape) and the music (filter signal processing), adding an additional layer of activity. Following prolonged inactivity, the system resets to the start screen. Following three minutes of continuous activity, a prompt appears, asking whether people wanted to continue (implemented to help staff and parents manage flow, instead of a hard cut-off).



Figure 9 Deployed Digitopia Interactive

Four tablets each were combined into two elongated pyramids, nicknamed the ‘toblerones’. These could be deployed on tables at the venues and then freely arranged in space (see **Fehler! Verweisquelle konnte nicht gefunden werden.**). Simple instructions were printed on the toblerones: ‘What does your Digitopia sound like? Join the dots to build your own Digitopia sound.’ The Digitopia Interactive was placed in the foyer of participating theatres, available for up to an hour before and after the Digitopia dance show. Alongside the Interactive, additional arts and crafts activities (also following the theme of geometric shapes) were available.

4. DIGITOPA INTERACTIVE TOUR

The Digitopia Interactive accompanied 22 of the 27 dance performances and was seen by over 2000 audience members (four special performances did not require the Interactive, and technical issues prevented its use at another show). In 15 shows the full complement of 8 tablets were usable, while 4-7 were functional for the rest of the shows.

We observed use of the Interactive before and after four performances at three different venues (N₁, N₂, D & L), amounting to

approximately 10 hours of study. We took field notes and conducted brief interviews with audience members where appropriate. At the end of the tour, we cross-analysed field notes and results provided by the arts and crafts team. Interviews with the dance companies production manager (PM) and artistic director (AD) were also conducted, to gauge the extent to which the interactive had fulfilled the set aims. Below, we first focus on the user experience and deployment considerations, before concentrating on the two aims of the production to 1) extend engagement into the foyer and 2) improve conceptual engagement.

4.1 USER EXPERIENCE

The Digitopia Interactive was designed primarily for young children. In practice and at all venues, the Interactive was used by children and adults of families, and also individual users, e.g. adults without families, and social groups, e.g. large birthday parties (at D). Our design required users to physically play with the visual components in order to discover how “dressing” and interacting with the pyramid created sound. We observed how children appeared not to seek instructions, but rather learned by trial and error. In contrast, adult users were tentative about touching the screen without knowing what effect it might have. We also observed how children almost always tried to *drag* components, and rarely pressed or tapped the screen. In contrast, adults almost always tried to *press* objects on the screen. As the app did not respond to taps adult users would occasionally be frustrated by an apparently static display.

As children explored the app further they typically discovered that the blue nodes of a dressed pyramid could be dragged to influence the sound; we did not observe any adults discovering this feature without first being instructed by another user. Children also typically progressed to using two hands to interact with the display. In addition to being more avid in their exploration of the app, we noted that children often treated fully dressing the pyramid as being the goal of the experience.

The majority of children dressed one pyramid then moved to other tablets to complete more (even though they presented the same visual elements). Some children created their own challenge to dress pyramids as quickly as

possible, with N_2 Pc13 for example stating: *“Look how quickly I can finish it now!”*. Having dressed a pyramid, many children relished the opportunity to teach other users (including younger siblings and their parents). For example, parent (Pa2) trying and then being guided by her child (Pc3): *“... let me show you how it works.”* Some children also took the time to undress their pyramid afterwards, dragging the lines back to their original position.

4.2 SHAPE AND SPACE

Information about the spatial or technical configuration of the various foyer spaces was not available to us, as it was not collected by the DC. Indeed, many venues had no obvious “foyer” space, and the Interactive was ultimately placed in spaces ranging from transitional (e.g. N a space linking the box office and café), and terminal (e.g. L where the Interactive was placed in a separate room connected to the café, and D where the Interactive was in a dedicated room several corridors away from busy spaces).

The choice of space naturally affected the extent to which visitors “stumbled upon” the Interactive, and whether the spectacle of the Interactive in use attracted attention. In N, noise from the Interactive carried into the café, thus regularly attracting visitors (honey-pot effect) on their way to the café or box office. When crowds did form around the Interactive in N, the timeout message and social pressure helped to regulate the flow of users: N_2 Pa21 (to Pc19): *“Look – its telling you that it’s someone else’s turn – you’ve been on it for ages and other children are waiting”*. In contrast, users in D and L had to intentionally visit dedicated rooms. In L, children would often visit the Interactive independently while their parents watched from the café next-door; in D, parents needed to accompany their children to find the Interactive. As children rarely needed help to use the Interactive, this often resulted in parents having to wait at the edge of the room.

4.3 EXTENDING BEYOND THE STAGE

The DC aimed to extend audience engagement beyond the stage and into the other venue spaces. We observed various forms of physical activity and social interaction emerging around the Interactive, such as some children creating

a spectacle to attract attention. For example, DPc3 and Pc4 put a line onto the shape then danced around the room for several minutes - Pc4 exclaiming: *“It’s great for dancing! Look at us!”* Some children also interacted with two tablets at the same time, which was then copied by others.

Despite often splitting apart to interact with tablets individually, families and social groups would typically reform as users attempted to perform for or with others. We saw friends and family members attempting to use the same tablets simultaneously. For example, N_1 Pc1 and Pc2 started to drag lines at the same time, Pc1 stating: *“... let’s see how quickly we can get all the lines on, together!”* When a large birthday group took over the interactive in D, and children explored the app at different paces, some quickly tried to teach others, when DPc8 called to Pc9: *“I want to do it myself! Stop showing off”*.

Due to concerns about noise, a small number of venues required that the Interactive be deployed with headphones rather than the external speakers. This impacted on social interaction, particularly during attempts to collaborate and share. In some cases, group members would interact with adjacent tablets but would swap headphones to let each other hear what sounds they could produce with the app. Younger children found sharing more difficult, attempting to ask questions and/or search for eye-contact from their parents, seemingly unaware that their parents couldn’t hear the sounds. N_2 Pc11 played with one tablet for 10 minutes wearing headphones, *“making funny sounds”*. She repeatedly asked her father whether he thought they were funny: he agreed but was visibly frustrated with not being able to hear them, finally taking over (Pa12: *“let daddy play so he can hear them”*). The DC’s PM specifically stated that they tried to discourage use of headphones as that hindered social interaction and spectacle.

4.4 CONCEPTUAL ENGAGEMENT

The AD was enthusiastic about the potential for the Interactive to reveal the components of the stage performance to the audience, allowing the audience to understand the show’s aesthetic. Adults without children were sometimes frustrated about the simplicity of the Interactive, with N_2 Pa15 stating: *“I don’t*

understand the concept – this is far too simple – I don't understand why I would want to use it – tell me more about the concept". On return from the show, parents could link the Interactive with the stage performance, but tended to suspect that their children might not be able to, with D Pa24 arguing: "The link with the show is probably wasted on the kids, but pretty clear to me. The dance and the music changes as the shape changes – just like when the shape changes on screen".

In practice, we found that children reasoned to different extents about how they could use the Interactive to create sounds. Some children moved between terminals to see if they behaved differently, and some collaborated to test this, for example when N₂ Pc13 states: "...they [two tablets] sound different – I think it's because we move different bits ..." and Pc14 responds: "no – we can do the same thing – move that line ... 1, 2, 3 ... mmm I don't know". Children typically stated that they were controlling the sound, but could not pinpoint the exact effect of their interactions, with for example N₁ Pa6 asking Pc4): "Can you hear what that does?" and Pc4 responds: "No – I'm just doing this [dragging lines] – it's cool". Some parents encouraged their children to take a rational approach to understanding the Interactive, for example D Pa20 stating to Pc21: "Look – you can stretch the blue bits [nodes]; what does the stretching do? Have a listen – get your head down [to the speaker]. Does it change the music?"

Making connections between interaction and sound seemed more difficult than anticipated. On one hand, although each tablet had a distinct set of instruments, children often found it hard to pick out the sound from their individual tablet above the sound of the others. For example, N₂Pc6 stating: "It's not working" with Pc7 responding: "It is – it's quiet – put your ears down next to that hole". While headphones improved the sound, they eliminated much of the social interaction around the Interactive. On the other hand, observation also suggested that the visual feedback was more immediate and interesting than the audio feedback. For example, N₁ Pa8 saying to his daughter: "Look – listen to what's coming out [sound] when you move them onto the lines. No? No, you're not bothered are you – you just like dragging things around".

5. DISCUSSION

The Digitopia Interactive evidently delivered the desired extension of the stage show into the foyer (aim 1). The DCs feedback made clear that provision of this opportunity for audiences to explore relationships between visuals and sounds – albeit somewhat ambiguous - was much appreciated (aim 2). Beyond addressing these two aims, our observations of the Digitopia Interactive highlight three emerging challenges when designing touring experiences for families.

Design for balanced experiences:

Our Interactive worked well for today's tech-savvy generation of children, the main target group of the work: it was intuitive to use, enabled exploration of the show's concept and encouraged social experiences. In this context, the project manager commented that 'there's something about constraints that means (kids) want to break through them.' Others, particularly adults, adopted it with some frustration. A study by Diamond demonstrates that children are more likely than parents to manipulate exhibits, whereas parents are more likely to look at graphics and read labels [22]. When we design for families, it is tempting to design for children, but is it possible to design balanced experiences especially in a framework with no predetermined trajectories of social interactions?

Design for unknown spaces:

For the AD, foyer spaces were of great interest and he stated that 'I think (foyers) should be social places, and some are and some are not.' We could not know what form the foyer spaces at the various venues might take and what kinds of social activities they might be good at supporting. We designed the interactive so that it could be flexibly arranged end-to-end or side-by-side to adapt to the venue's foyers, while the spacing of tablets within the 'toblerones' provided a comfortable space for individuals and small groups to interact with one tablet, and to observe another users without invading their personal space. When it is impossible to predict the spatial and social arrangement in the space, the challenge is to design a flexible experience that can be accessed by one or more children, or children and adults together, and to avoid prescription [23].

Design for conceptual reflection and reconfiguration:

Key to achieving aim 2 was the way that “without being pedagogic ... we deconstructed and educated the audience in the different components of the piece [dance show]” (AD). Our observations suggest that the conceptual links may have been more ambiguous for younger users, however it didn't seem to matter to them or the DC: the exploratory engagement with the basic visual and audio components was enough. There was a clear tension though: when headphones were not used users were more likely to engage in social interaction, but less likely to focus on the link between the visuals and sounds, and to quote the AD: ‘If it is about creating sound then you want that sound to be of high quality don't you (via headphones)? So it is going to impact you ... (the final design) is more social I think, and it is a social experience that people are having really’. The challenge here is to design an interactive experience that enables users to explore the fundamental components of the performance while being immersed in a socially engaging foyer space.

6. CONCLUSION

The Digitopia interactive accompanied the UK tour of the Digitopia dance show. Adults and children made use of the extension of the Digitopia theme into the foyer spaces of the tour venues before and after the show. This allowed for extended and individual engagement with the abstract themes of Digitopia exploring the relationships of graphics and sound.

7. ACKNOWLEDGMENTS

We would like to acknowledge Tom Dale, Claire Summerfield, Jo Wills, Lakeside Arts Centre Nottingham and Moko Dance. We are grateful for the funding received from the Horizon Media Campaign and the University of Nottingham via the Nottingham Research Fellowship ‘The Built Environment as the Interface to Personal Data’.

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