Indoors and outdoors:
designing mobile experiences for Cité de l'espace

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Abstract: The CHESS project has been working with Cité de l'espace, a space technology centre, to explore the use of tablets and mobile phones to deliver visitor experiences that integrate across multiple experiences. In this paper, we articulate three key challenges present at Cité, describe a prototype experience developed by CHESS, and present a set of observations developed through an evaluation conducted in October 2012.

Keywords: mobile experience, cultural heritage, museums, technology probe, evaluation

1. Introduction

Cité de l'espace (CITE) (2013) is a science centre in Toulouse which specifically focuses on space exploration and technology. For the last two years, the CHESS project has been working to prototype and evaluate novel visitor experiences in collaboration with CITE. These experiences consist of fictional stories, told through the medium of an iPad, and incorporating audio recordings, video, photographs, interactive games, text and augmented reality. Visitor experiences mediated through mobile communication devices have been a focus of research for some time (see Abowd et al. 1997; Yiannoutsou et al. 2009) and are increasingly prevalent in cultural heritage institutions. Work at CITE has explored novel and appropriate approaches to designing effective experience, which have then been evaluated through the observation of naturalistic deployments and through interviews.

CITE presents significant challenges for the design of experiences, which are then relevant across the cultural heritage sector more broadly. Several key challenges have been identified through a variety of interactions, including ethnographic studies (Tolmie et al. 2014), public discussions with museum professionals (ECSite 2012) and interviews and design sessions with CITE staff. Challenges include:

Responding to an existing site: CITE presents a large number of exhibits, and museum directors would like to deploy experiences that tell stories which span across multiple exhibits. However, existing exhibits have not been designed with mobile experiences in mind. As such, design work has to carefully consider the challenge of how to integrate experiences into existing exhibits.

Navigation and wayfinding: CITE has a large and open site, with both indoor and outdoor exhibits. GPS will not work indoors, and indoor positioning systems, though present at this particular site, drain the battery capacity of mobile devices at an unacceptable rate. Methods are therefore needed to guide visitors to particular locations without the aid of a positioning system.

Designing visitor journeys through experiences: In seeking to design experiences that integrate across multiple exhibits, care is needed in establishing designs that provide for coherent experiences. Visitors need to be taken on a journey through the site in order to be provided with a story that is believable and immersive.

In seeking to address these challenges, our approach has been to develop a series of technology probes (Hutchinson et al. 2003). These are robust, usable but potentially incomplete prototypes that are introduced early in the process of design, which illustrate key features of systems, and which allow for the development of knowledge that will inform the design of technologies in the future. In this paper, we present a technology probe deployed in autumn 2012, consisting of a mobile experience which offered a choice between two fictional stories entitled “The Secret Diary of Philippe Perrin” and “Become a Reporter in the Year 5000 AD”.

We begin this paper by presenting aspects of the design of this probe that respond to the challenges presented above. We then describe our chosen evaluation method, present key findings from an analysis of data collected during deployments, and discuss the implications of these findings for cultural heritage institutions.

2. Probe design

2.1 Responding to an existing site

Visitors to CITE will have a broad range of interests and intentions. We chose to provide two stories so that visitors could select their preference. “The Secret Diary of Philippe Perrin” focuses on the use of audio recordings to express a fictionalized diary written by Philippe Perrin, an astronaut who took a single trip to the International Space Station. “Support a Reporter from the Year 5000 AD” features a character who is a reporter from the future, and who intends to write an article on “space technology of the past”. The design and production of both stories was targeted at children, due to prior ethnographic work suggesting that children tend to lead the visit at CITE (Tolmie 2013). On arrival, visitors are given a choice between the two stories, using an interface shown in figure 3.

To allow for the possibility of families who wish to work through both stories in parallel, both were constructed around the same five selected locations, four of which are museum exhibits. Table 1 provides a description of these, and figures 1 and 2 then illustrate a number of these locations. A key challenge is then the design of an immersive experience that integrates across these five locations, which are some of the most important exhibits at CITE.

Table 1: Locations featured in experiences

Name	**Description**
Entrance hall	The main entrance to the museum, a large space containing a ticket desk and a series of entrance barriers.
Parterre des Planètes	A model of the solar system, presenting scale-models of each the planets (fig. 1).
Arianne launcher	A full-size model of a European Space Agency launcher, linked to an internal exhibition space (fig. 1).
Soyuz capsule	A real Soyuz capsule. Visitors can climb inside when members of staff are present, and otherwise can look in through a glass door.
Mir space station	A replica of the Mir space station. Visitors can observe the Mir from the outside (fig. 2), and can walk through the inside (fig. 7), which presents a re-creation of life in space.

A description of the five key locations featured in the two stories

To provide an integrated experience, media presented on the iPad draws on these exhibits as a reference point, and uses this media to tell a story that spans the exhibits. In the case of the “Secret Diary of Philippe Perrin”, each exhibit is associated with a diary entry describing different stages of a trip into space, which culminates with a rich set of diary entries presented at the Mir which are used to illustrate the life of an astronaut living on a space station. “Support a Reporter from the Year 5000 AD” is presented from the perspective of a reporter from the future, who discusses the nature of the technology involved in each exhibit, and who asks the user to perform a variety of activities such as capturing photographs. At the conclusion of the experience, photographs are then integrated into a pre-written newspaper article which acts as a souvenir.

Figure 1: Parterre des Planètes and Ariane model (source: CITE)

Figure 2: Mir space station replica. A walk-way provides access to the interior space (source: CITE)

Figure 3: Interface used to select stories (Source: CHESS project)

2.2 Navigation and way-finding

The two experiences outlined above are both constructed around four exhibits and the entrance hall, and functionality to support navigation to and from each exhibit seemed important. Given that the site combines indoor and outdoor elements, and given that no usable positioning system could cater for both, our approach in designing the probe was to integrate photo-based navigation, a novel approach in this kind of experience. Exhibits at CITE are large and recognizable, and we believed that a relatively small bank of statically or dynamically annotated photographs could support visitors in the process of navigation. Figures 4 and 5 illustrate typical navigation interfaces integrated into both experiences. How this navigation system worked in practice is then considered in our evaluation.

Figure 4: Specific navigation screen, used to take visitors from one important location to another (source: CHESS project)

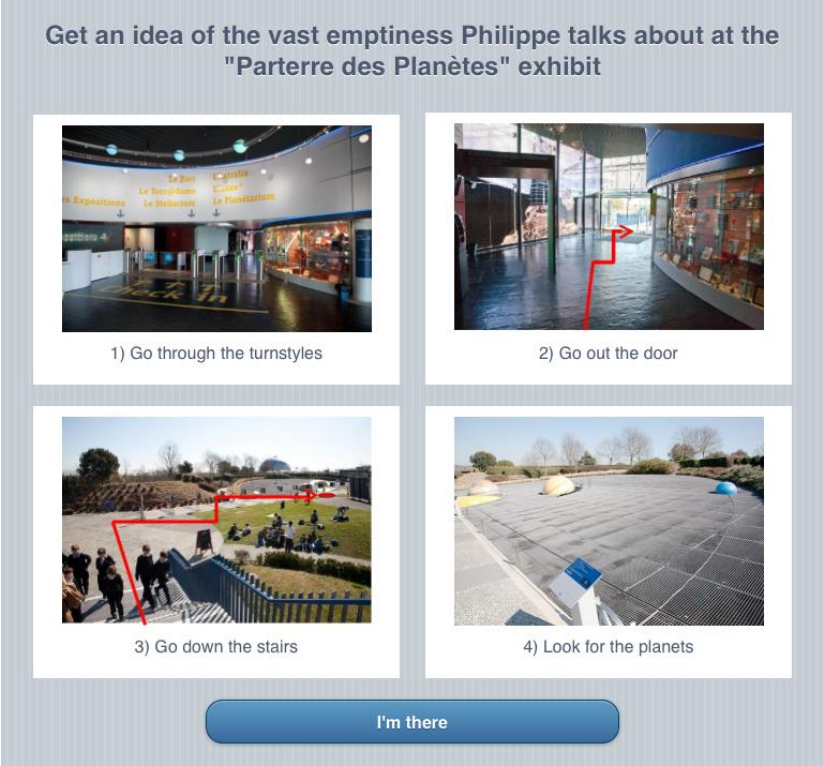

Figure 5: General navigation screen, accessed by visitors who have become lost, disorientated or who have taken a break from the experience. Arrow indicates location of next important exhibit (source: CHESS project)

2.3 Designing visitor journeys through experiences

Work by Benford et al. (2009) has highlighted the importance of carefully designing the journeys that users follow through a particular experience as a whole, so as to carefully frame individual interactions so that they make sense to visitors. These journeys, otherwise known as “trajectories”, can be thought of at multiple levels, including the trajectory of the experience through the whole site and the trajectory at particular exhibits. The Mir space station exhibit provides an interesting case study for the design of an effective experiential trajectory, in that it sits at a natural transition point between outdoor and indoor space. Visitors generally arrive at the Mir after viewing some of the larger outdoor exhibits, including Ariane and the Parterre des Planètes. Due to the positioning of the exit ramp from the Mir, it is then natural for visitors to enter a large indoor exhibition hall after leaving it. The Mir provides an interesting opportunity, in that it is positioned in a large outdoor space which is mostly devoid of content. It also presents an interesting challenge for interaction design due to the nature of the pathway through its interior, which is narrow, and which can easily become overcrowded with visitors.

The Mir exhibit was an inspiration for the “Secret History of Philippe Perrin”. It is the final exhibit featured in this particular experience, and is used to provide a climax to this story. We were therefore very careful to design a trajectory through this exhibit that made best use of it. To do so, the following interactions are included:

1. Navigation photographs clearly indicate that visitors should stop in the space outside of the Mir, rather than entering it directly
2. Digital content then gives families the opportunity to take a photograph of their children posing as astronauts (fig. 6)
3. Visitors can listen to a fictional diary entry from Philippe, presented as an audio recording voiced by an actor, in which he describes his feelings on approach to the International Space Station
4. Navigation photographs then prompt families to enter the Mir
5. Four QR codes are placed within the Mir (fig. 7). Each is linked to a video describing life in a space station, and showing astronauts living in the real Mir as it orbited Earth
6. On exiting, visitors are presented with a final diary entry in which Philippe describes his feelings as he left for home, and in which he describes his reasons for never going into space again. The experience then ends at this point.

Figure 6: Family photograph before entering the Mir (source: CHESS project)

Figure 7: Viewing a QR-linked video in the Mir (source: CHESS project)

3. Evaluation methodology

For the purpose of evaluating the probe, we recruited seven groups, all of whom had visited CITE previously. Each group included at least one adult, and at least one child who was between the age of seven and twelve (to match the core demographic at CITE). Table 2 summarises recruited participants. This was an exploratory deployment, and we gave families either one or two iPads so that we could learn about the impact of this choice. Group 6 was composed of two families who visited together, with each mother being accompanied by two children. This stage of the evaluation itself took place on a single day in the autumn of 2012.

Table 2: Participants recruited for evaluation

Group	Adults present – relationship to children	Age and gender of children (m/f)	iPads
1	Mother	9 (m)	2
2	Mother and grandmother	6 (f) and 9 (m)	2
3	Mother and father	7 (f) and 8 (m)	2
4	Mother and father	8 (m) and 16 (m)	2
5	Mother and father	4 (f) and 9 (f)	1
6	Two mothers	7 (f), 9 (f), 9 (f) and 11 (m)	2
7	Mother and father	11 (m) and 13 (m)	1

A description of the participants who were recruited for the probe evaluation

Members of each group were given free access to CITE for the whole day, and were allocated a time-slot for the study. At their allocated time, group members met us in the CITE entrance hall and were provided with iPads which had been pre-loaded with the experience. They were first shown the experience summary screen and were asked to make a choice between the two stories on each iPad. They were then told that they could take as much time as they wished to explore the experience.

To support the analysis process, all group members were fitted with lapel microphones which were connected to audio recorders placed in their pockets. Their interactions with the system were discretely video-recorded, generally from a distance, but occasionally close-up to reveal fine details of important interactions. Later in the day, a group interview with the family was audio-recorded to provide an opportunity for them to discuss their responses.

At the conclusion of the study, we collected and organized all available video and audio material. This was then studied, in detail, by a panel of researchers familiar with qualitative analysis process. The focus of this process was on identifying interactions which provided interesting insights in relation to the design challenges articulated earlier in this paper.

4. Findings

There is a substantial history of the use of technology probes in human-computer interaction research. In keeping with this tradition, much of our analysis focused on identifying and understanding points of breakdown, i.e. interactions which evolved in an unexpected manner. Frequently, an understanding of points of breakdown can lead to insights into how to design future systems. Based on our analytical work, we present five observations, all related to the three key challenges identified in the introduction to this paper.

Locations must be precisely defined for photo-navigation to be effective

In general, photo-based navigation support worked well, and visitors found their way to the correct location with relative ease throughout both experiences. We often observed families having brief group discussions about how to follow particular directions, but these were generally resolved quite quickly.

Photo-based navigation broke down where navigation to a very precise location was required by a piece of content. This was particularly clear in relation to a piece of AR content placed at the Parterre des Planètes, which featured the planet Pluto. Because Pluto is relatively small in comparison to the other planets, visitors often fail to see this model, and the AR content was designed to draw attention to it. However, the design of the content required visitors to stand close to a very specific location. The Parterre itself is roughly ten metres wide, and photo-based navigation instructions were not sufficiently precise. This then meant that some visitors accessed the content from the wrong location. Photo-based navigation systems may need a mechanism for guiding visitors to really precise positions where precision is required – which is frequently the case with AR content. Alternatively, content design may need to be more flexible to positioning errors.

Existing features can be used to overcome difficulties with ambient light

Strong ambient sunlight is present throughout most of the outdoor environment at CITE, and can cause difficulties with interaction with mobile devices. Working from experience gained through earlier trials, our design featured simple interfaces with bold text and graphics in an attempt to maintain legibility. However, interaction with this interface was still difficult in some locations. Even given advances in technology this is likely to remain the case for some time to come.

In particular locations, we observed visitors adjusting to ambient light by locating shady positions, such as cafes, for interaction. This was particularly noticeable at the base of the Ariane, where a café was sufficiently close to the launcher to allow for meaningful interaction in the shade. Most outdoor exhibitions will have some areas of shade that can be utilized to support interaction, and hence experienced designers might choose to design content which can be interacted with in shady locations. Similarly, audio-based interactions might work best in locations known to be quiet.

Transitions into indoor spaces can disrupt other visitors

The four QR-code-linked videos presented in the Mir were the most popular part of the experience. Interviews with our visitors suggested that they had an AR-like quality to them, in that they showed what the inside of the real Mir looked like to visitors who were standing in a replica. Visitors were observed to spend quite a large amount of time interacting with this content, which suggests that this part of the design was successful. However, even on a quiet day, a significant queue built up outside of the Mir, due to the extra time that our visitors spent inside. A possible contributing factor here was that videos were placed in a slightly wider space just inside a door providing for a transition from outside to inside, with no windows providing a view to the outside. As such, our visitors could not see the size of the queue that was forming, and could not adjust their behavior accordingly. This

breakdown then suggests that careful attention needs to be paid to the placement of content. It might be possible to integrate findings from research that considers the impact of lines of sight (e.g. approaches such as space syntax [Hillier and Hanson 1984]).

Physical markers need to be provided for content

In the Mir, video content was tied to physical markers, in the form of QR codes stuck onto available surfaces. However, in the rest of the experience, video and audio content was not tied to markers, due to difficulties in making modifications to exhibits. Instead of scanning codes, visitors used an on-screen button to self-report when they arrived at an exhibit, and were then provided with relevant content. In some cases, content was linked to certain interactions. For example, the video of a real Ariane being launched was intended to be viewed from under one of the model rocket engines, and visitors had to angle their iPad upwards for the video to be triggered.

Although this approach worked reasonably well for most of the interactions, breakdowns were encountered in some cases. Some visitors missed important content entirely, due to errors in navigating through the iPad interface. Other visitors reported in the post-experience interview that they had become worried about not finding all of the content, and were observed to search around exhibits to make sure that they had missed nothing. Some visitors misunderstood navigation functionality which encouraged them to watch the Ariane video whilst under the model engine. Though they did watch the video, it was then not in the intended place, and potentially not as immersive as planned by the designers.

Our conclusion is then that there is an advantage to incorporating physical markers into exhibits, as carefully designed markers can reduce some of the difficulties identified above. Where this kind of modification is not possible, then non-invasive mechanisms (such as projection) could be explored.

Choice must be accompanied by sufficient information

Interviews with participants suggested that making a choice between the two stories was difficult, due to insufficient information being provided about the nature of these experiences in the interface presented in figure 3. A number of participants felt that their choice was relatively arbitrary, and that they chose the story whose purpose they found easier to understand (which was universally “The Secret History of Philippe Perrin”). Mechanisms for providing hints about the content of experiences could be explored, and this issue is discussed in further detail below.

5. Conclusions and further work

The probe and evaluation presented in this paper have proven extremely useful in developing our understanding of how to design effective mobile experiences. The observations presented above, though derived from work at CITE, have the potential to be relevant to museums and the cultural heritage sector more generally. Working from these observations, the following topics for research seem interesting, and will be actively pursued in the future:

1. *Environment mapping to support mobile experience design*

An environment map, potentially illustrating areas of shade and quiet within a particular environment, could be a useful addition to the process of designing mobile experiences. How could such a map be generated, and how might it be represented?

2. *Experience trailers to support choice*

Trailers, lasting several minutes, are regularly produced for feature films. They support potential viewers to quickly work out what a film is about, and support the process of deciding whether to invest time in viewing it. A trailer for a mobile experience could be produced, and might be beneficial in supporting choice and decision making. What features might an experience trailer include, and how might it be presented?

3. *Mechanisms for supporting more precise positioning through photo-based location*

Photo-based navigation systems clearly have potential, but may need to support more precise positioning. How can a precise photo-based system be developed? Does it require the integration of features into the environment itself?

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References

Abowd, G., Atkeson, C., Hong, J., Long, S., Kooper, R. & Pinkerton, M. (1997). Cyberguide: A mobile context-aware tour guide. *ACM Wireless Networks.* 3(5),421-433.Benford, S., Giannachi, G., Koleva, B. And Rodden, T. (2009). From Interaction to Trajectories: Designing Coherent Journeys Through User Experiences. In *Proceedings of CHI 2009.* New York: ACM Press.

Benford, S., Greenhalgh, C., Crabtree, A., Flintham, M., Walker, B., Marshall, J., Koleva, B., Rennick Egglestone, S., Giannachi, G., Adams, M., Tandavanitj, N. & Ro Farr, J. (2013). Performance-led research in the wild. *ACM Transactions on Computer-Human Interaction (TOCHI) - Special Issue of “The Turn to The Wild“.* 20(3).

Cité de l'Espace. (2013). *Cité de l'Espace.* Retrieved from http://www.cite-espace.com/.

ECSite 2012. *Pre-Conference Workshop: Designing interactive mobile experiences*. Retrieved from http://www.ecsite.eu/annual_conference/call-for-proposal/proposed-sessions/pre-conference-workshop-designing-interactive-

Hillier B. and Hanson J. (1984), *The Social Logic of Space*. Cambridge University Press: Cambridge.

Hutchinson, H., Mackay, W., Westerlund, B., Bederson, B.B., Druin, A., Plaisant, C., Beaudouin-Lafon, M., Conversy, S., Evans, H., Hanson, H., Rousell, N., Eiderbäck, B., Lindquist, S. & Sundblad, Y. (2003). Technology Probes: Inspiring Design for and with Families. In *Proceedings of CHI 2003*. New York: ACM Press.

Tolmie, P., Benford, S., Greenhalgh, C, Rodden, T. & Reeves, S. (2014). Supporting Group Interaction in Museum Visiting. In *Proceedings of CSCW 2014*. New York: ACM Press.

Yiannoutsou, N., Papadimitriou, I., Komis, V. And Avouris, N. (2009). Playing with Museum Exhibits: Designing Educational Games Mediated by Mobile Technology. In *Proceedings of Interaction Design for Children 2009*. New York: ACM Press.