

# Studying the Role of Interactivity in Museums: Designing and Comparing Multimedia Installations

Pedro Campos<sup>1,3</sup>, Miguel Campos<sup>2</sup>, João Pestana<sup>2</sup>, and Joaquim Jorge<sup>3</sup>

<sup>1</sup> University of Madeira and Madeira Interactive Technologies Institute  
9000-390 Funchal, Portugal

<sup>2</sup> WowSystems Inc., R. Mary Jane Wilson 23 G, 9050-446 Funchal, Portugal

<sup>3</sup> VIMMI Group, Visualization and Intelligent Multimodal Interfaces, INESC-ID

R. Alves Redol 9, 1000-029 Lisboa, Portugal

pcampos@uma.pt, miguel.campos@wowsystems.pt,

joao.pestana@wowsystems.pt, jaj@inesc-id.pt

**Abstract.** Interactive installations for museums are a particular kind of interactive systems, the design of which has been the subject of several research studies. However, the aspects of a rich, cultural experience are easily overlooked in a technologically driven system design and there are few studies that actually compare the role of different interaction styles (such as *touching* versus *walking*) on the museums visitor's experience. We present our experience of designing a cultural interactive multimedia exhibition, comprised of four sensor-based interactive installations, and two non-interactive installations. Our results were organized around usability problems detected, social interaction issues and differences between interaction styles, and suggest that the most enjoyable installations are those which facilitate collaborative activities as well as those making a creative use of sensor-based technology.

**Keywords:** Interactive installations, sensor-based interfaces, public settings, cultural exhibitions.

## 1 Introduction

The use of sensor-based interactive installations, in particular installations involving infrared motion sensors as well as cameras coupled with real time video processing algorithms, have been receiving considerable interest both from industry and academia [1, 2, 3, 5]. During the design and evaluation of interactive exhibitions, much can be learned about interaction design for public settings like these.

We describe our own experience designing and evaluating an interactive exhibition, which featured four different interaction styles to control digital contents: touching, walking over, waving and page-flipping. Our design approach was tailored to the exhibition's contents and makes a creative use of sensor-based technology, with the explicit goal of reducing the distance between visitors and cultural heritage [7].

The traditional view of culture-related exhibitions is that the visiting space should be well conceived in terms of volumetric layout so that it can essentially serve as a

quiet contemplation space. Current approaches are still based essentially in static paper-based displays that are manipulated by artists who try to make them more appealing. However, with the advent of novel technologies, particularly multimedia projections and sensor-based installations, the museum directions and the exhibition's cultural and artistic directions are starting to embrace new digital media as effective ways of approaching people to cultural heritage, as opposed to considering those media as a menace to traditional means of cultural dissemination. Our experience suggests that artists have the potential to provide novel, creative uses to technology, and the opposite as well: interaction designers and technologists have the potential to provide artists with techniques which effectively enhance their portfolio.

The remainder of this paper is organized as follows: the next section describes related work with a particular emphasis on research approaches to add interactivity to cultural heritage exhibitions and museums. Next, we describe the interactive installations designed, as well as the interaction styles employed in our exhibition, titled "Cultural Tourism". We move on to describe the evaluation approach and results, drawing some conclusions, which were organized around usability problems detected, social interaction among visitors and differences between interaction styles. Section "Conclusions and Future Work" outlines new avenues of research for this field.

## 2 Related Work

Technology today provides exciting new possibilities to approach museum visitors to culture and heritage. And many art museums are struggling to identify innovative approaches to engage new audiences in their exhibitions.

Danks and colleagues [1] refer the focus shift towards using interactive artifacts to enhance the visiting experience, which contrasts with the traditional approach, centered on the museum's collection, display and storage of objects. They argue that today's museum visitor expects to learn while also having fun at the same time, therefore interactive storytelling and gaming have a great potential to improve modern museum's experiences [1].

Several experiences have been conducted to study how visitors experience novel interaction styles within museums and science centers. Explore@Bristol, for instance, was an interactive science museum, which was studied to analyze six of its exhibits according to three dimensions: *Drama-Sensation*, *Challenge-Self Expression* and *Social* [5]. The exhibition titled a "Walk in the Wired Woods" illustrates how to design an engaging experience through context-sensitive media and interaction. The visitors were invited to take a walk in which they were automatically presented with audio content appropriate to their physical location [6]. Other interesting studies have been performed, regarding novel interaction styles and schemes, applied both to leisure and educational activities. Such examples include "The Fire and the Mountain" exhibition, held in 2006 at the Civic Museum of Como, Italy [4] and the "Listen Reader" from Xerox PARC, an innovative and engaging reading experience installed in three different museums over a six-month exhibition period [3].

Some researchers have devoted effort into studying interactive installations using mixed-reality [8], in the context of art museums. Expressing the formal aspects of the original artworks, the interactive installations allowed visitors to explore specific

conceptual themes through their interactions. Sometimes, researchers also exploit an augmentative approach, adding interactive elements to the displays and artworks of the exhibition [9]. Taking great care to ensure that the installations meld seamlessly into the setting is considered very important, so that visitors don't face the interactive installations as a kind of "computer section" of the museum or exhibition.

Experiments on augmenting art museums with interactive technology have also been documented. For instance, Terrenghi and Zimmermann [11] introduce the notion of 3D sound in headphones for an art museum, providing the user with a contextual and spatial audio guide. This technology is an advanced version of more traditional audio guides. However, the approach still provides only an individual and detached experience, since no conversation is possible while listening to the audio. This communication approach does not disturb the experience of purely visual artworks, however it would be difficult to combine with artworks that contain sound by itself.

The use of abstraction and motion in the design of social interfaces – for which the interactive cultural exhibitions are a special case – has also been explored [10]. Particularly useful for our research was the concept of *perceptual causality*, which suggests that simple displays in motion can evoke high-level social and emotional content.

A particular requirement for designing our interactive installations was the goal of captivating children. Mark Prensky stated: "Our students have changed radically. Today's students are no longer the people our educational system was designed to teach." [12]. The same philosophy applies to the younger visitors of a museum. It is not enough to simply add technology to some of the exhibition's modules, designers need novel approaches to reduce the distance between children and cultural heritage and new interactive techniques to stimulate active participation, involvement and learning by children visiting a museum, through ubiquitous computer technology. A good example is provided by [13], who undertook a systematic design process, which involved exploring Scenario-Based Design, Design-Based Research and a number of technology probes. The evaluation took a case-based approach using video recording and post hoc analysis of the activities, discussion, reaction, and questioning by the children who visited their exhibition, both as individual participants and in interactive groups. The data derived from these video recordings was analyzed in the context of eight design themes, which informed the development of the novel, computer-augmented museum exhibition.

When studying visitors' interaction with museum digital installations, the problem of evaluation arises inevitably, since it's neither easy nor clear to establish the right set of methods in order to draw credible conclusions. Hornecker and Stifter [2], reporting on the evaluation of a digitally augmented exhibition on the history of modern media, based their conclusions on (i) logfiles' analysis, (ii) interviews and (iii) observation in the museum. We also followed this approach as a means to obtain a better understanding of the interactive installations role in the exhibition, described in the next section.

### 3 The "Cultural Tourism" Exhibition

Museums, as well as the cultural exhibitions they organize and create, are a heterogeneous set of institutions whose original twin functions of scholarship and education,

once inseparable, but subsequently divorced, are being reunited by digital technologies. These technologies not only facilitate and/or accelerate long-established learning tasks, but, critically, they allow activities that would otherwise be impossible. This includes new approaches to learning by different audiences and for different purposes.

We designed a set of sensor-based installations in a cultural exhibition organized by the Direction of Cultural Affairs, which aimed at showing the visitor the cultural richness that formed the streets of Funchal (Portugal). The concepts of the exhibition revolved around promoting awareness about, and fostering a better understanding of, the cultural tourism that can be performed by simply walking through strategic streets and watching certain buildings, sites, and heritage. To better complement the exhibition's traditional large-format printed panels, the organizers wanted to have the interactivity factor as a means to add value to the visitor's experience.

The final set of interactive installations was comprised of: (i) a virtual book that could be browsed by simple page-flipping gestures performed in mid-air; (ii) an interactive floor that illustrated the evolution of the transportation means along the years; (iii) an interactive timeline using a touch-screen and (iv) a panel with projected images that would change through waving. The final set of dynamic but not interactive installations was comprised of (i) an immersive room featuring a 360-degree projection of traditional fireworks and (ii) a ceiling projection.



**Fig. 1.** The first interactive projection, which is “activated” through waving.

Figure 1 illustrates the beginning of the visit. A panel suspended from the ceiling is the projection surface for an interactive installation aimed at displaying ancient photos, which depict the evolution of the transportation means, and the cultural habits associated to it. Pictures were activated by simple waving gestures in front of the panel, as shown in Figure 1. The artists wanted to align the static panels, which they had in mind for displaying other contents, with the multimedia installations, so this installation's design was constrained by that goal. It is interesting to note that this is the sort of aspects that HCI researchers and interaction designers wouldn't think about during the design of such an interactive installation: the material of the medium (the

projection surface), as well as its placement. We found this to be an important success factor in the exhibition.

Moving on, visitors could find an interactive historical timeline, which consisted of a conventional 42-inch touch screen. Cultural directors usually employ timelines in books, panels and lectures. It's the most common format for displaying historical events and dates. The choice of the interaction style and the whole design of this installation were, therefore, immediate. From a research point of view, this was interesting because it allowed a more conventional interaction style (touching), which could be studied and compared to the other styles.



**Fig. 2.** The interactive floor about the transportations' culture (top) and the virtual book, which can be browsed by page-flipping gestures performed in mid-air (down)

Next, as illustrated by Figure 2, were another two interactive installations: an interactive floor illustrating the cultural aspects of the means of transportation, e.g. how people gathered together and exchanged goods when a ship arrived to the harbor (in the 1920's this was considered a major event). The design idea was to tailor the interaction style to the content being conveyed, i.e., make visitors walk over in order to get to know the way people walked and moved in the old days.

A second part of the exhibition featured two non-interactive installations: an immersive room featuring a 360-degree projection of traditional fireworks, which is illustrated in Figure 3, and a ceiling projection depicting the process of designing Arab mosques' ceilings.

The design rationale followed for the immersive 360-degree room, was to grab the attention of a second target group of visitors: tourists. The idea was to show visitors a glimpse of Madeira island's famous New Year's Eve fireworks display, a major event that attract thousands of tourists every year, and is currently Guinness World Record for the largest fireworks show on Earth. Since the typical Madeira Islands tourists are over fifty years old, both the artistic and multimedia staff decided not to use another interactive installation, but instead to design for contemplative minds. This ended up as the most enjoyable installation: visitor's reaction was tremendously positive and every visitor, especially children, devoted more time to this installation than to any other. This suggests that the interactivity factor is not necessarily crucial to the success of an installation, if we regard success as merely the visitor's level of satisfaction. We will discuss this a bit more in the next Section of this paper.

## 4 Discussion

The main customers for this Cultural Interactive Exhibition were architects, artists and designers who were interested in conceiving the best possible ways to provide an interesting exhibition. The design and development processes were therefore a collaborative effort between our interaction design team and these user groups. The interplay between these two groups was very interesting, during the design phase. This comment expressed by one of the designers/programmers was common to many others: *“Change was constant - and communication was a true challenge, since it was difficult for them to communicate us the whole point of. And when we moved from the laptop to an actual kiosk or projection, we noticed how different their opinion was regarding every aspect of the design and development”* (Developer/Designer).

Another interesting observation was: *“They [the artists] were completely focused on the MS PowerPoint model - they thought kiosks and interactive installations had to be designed and programmed as if they were PowerPoint presentations”* (Developer/Interaction Designer).

Therefore, in a cross-disciplinary project like this, the main challenge was related to communication issues with the artistic direction of the exhibition. Traditionally, artists regard the engineers as mere functionality builders, and the engineers regard the artists as creators of impossible-to-implement products. Adding to the difficulty, there is the language barrier, which is full of jargon (both for artists and for engineers).

The creative use of sensor-based technology was crucial to the success of the project. In practice, how was innovation promoted and how can this be better achieved? First of all, we observed that traditional techniques for fostering creativity still apply. Brainstorming is still very useful, practical and quick. Secondly, we observed the importance of natural interaction: the virtual encyclopedia can be used the same natural way one uses a real book: by simply flipping its pages. The interaction style chosen should be naturally coherent with the content and message conveyed by the product. Speed is always an issue that researchers usually don't have to concern about, but a crucial issue for companies. This implies that whichever innovation process we adapt and follow, it has to be an agile process, given the state of today's turbulent business environment. The ability to make changes quickly is also desirable. In this particular exhibition, the client wasn't happy with the full contents of the interactive installations and continued asking for small additions or corrections almost until the first opening hour of the exhibition.

We organized the remaining most interesting issues around the following themes: usability problems found during visitor's interactions, social interaction issues, differences between the interaction styles, and learning effectiveness.

While some of the installations were created solely as experiential activities, providing an increase in the level of learning by adding facts to an already well-formed body of knowledge, others were designed to support reflective learning [14]. Furthermore, we were also interested in observing the group behavior of the visitors, finding out how collaborative activities can be supported as a feedback mechanism to enhance engagement and learning motivation.

## 4.1 Usability Problems Found

In general, children had no difficulties interacting with the installations, even though most of them had never used interactive installations of the kind. Older visitors were more averse to interacting and preferred to simply watch. Some visitors didn't immediately realize the installations were interactive: people are not used to this kind of exhibitions. Affordances are needed so that visitors know they can interact with the installations: this would have grabbed much more attention and visitors. For instance, the interactive floor's first version displayed a series of ancient photos and when people walked over it, the photos changed using a mosaic-like effect. After the initial day of observation, we had to add a "walk over me" label, since adult visitors never had a clue and didn't realize that it was supposed for them to walk over the floor. This didn't happen to children, who understood what the floor was for, even with no label or any other clue. Traditional HCI design principles, in this case the importance of affordances, also apply to interactive museum installations. Since these interactions are a relatively short usage time experience, if the visitor doesn't understand the installation's purpose and usage in the initial minutes (even seconds), then the installation won't be effective in supporting the user's visit.

Other usability problems derived from visitors "carrying" the interaction styles from one installation to the other. For instance, after interacting by touch with the historic timeline, visitors moved on to the interactive page-flipping book. Although visitors quickly understood all they needed to do were page-flipping gestures in mid-air (and they quickly understood that the system used motion sensors to interpret the gestures), they also assumed the book's screen was touch-sensitive, and started interactions by touch, which weren't supported by the hardware, of course. The same happened when visitors reached the final two installations, which were not interactive: They assumed they were also interactive, and made pointing and waving gestures. However, this didn't influence the success of these installations, which were perceived as being very engaging by visitors of all ages.

Finally, another usability defect that we discovered only through the questionnaires and surveys was the lack of an index and table of contents to the virtual book. However, we didn't implement this feature, since the screen wasn't touch-sensitive. One advantage of the page-flipping style is that it's too close to the real paper-based book and doesn't provide the navigation means of the digital media, like hyperlinks.

## 4.2 Social Interaction

As we mentioned, there were much higher levels of social interaction among children than adults. But the most successful ones were clearly the page-flipping gestures performed at the virtual book and the interactive floor, both of which clearly fostered social interaction between visitors. The interactive floor, in particular, allowed collaborations between visitors that wanted to discover the images underneath them and sparked conversations (about culture) between visitors who interacted with the floor at the same time. A third observation regards the immersive 360-degree room. Since this was a dark room with loud fireworks, we were expecting lower levels of social interaction. However, the opposite happened and visitors' social interactions reached the highest level in this room. One explaining factor might be the mere enjoyment that

was manifested because of the immersive factor: It's a show of lights and people were more comfortable to make comments to one another while inside that room.

Finally, we studied how collaborative activities can be supported as a feedback mechanism to enhance engagement and learning motivation. In this sense, we observed the interactive floor was particularly effective, since it was frequent to observe the kind of comments like "look how they walked in those old days" between two or more visitors who were experiencing the interactive floor in the third person, i.e. watching others walking over it.

### 4.3 Differences between Interaction Styles

We observed that there was a tendency to "transport" interaction styles from one installation to the next, i.e. visitors trying to "page-flip" a touch-screen. The collaboration that was allowed by the interactive floor's walking over style clearly enhanced the level of engagement as well as their focus. Regarding the virtual book, it was interesting to note the important role of affordances, which proved adequate to the interaction style: the visitor browses the virtual book the same way he or she browses through a real book. We were expecting more difficulties from visitors, since it's a particularly unusual interaction style. But as we mentioned in the previous section, *page-flipping* and *walking over* were the most preferred interaction styles.

### 4.4 Learning Effectiveness

While some of the installations contributed to a better learning experience, such as the virtual book and the historic timeline, others seemed better fitted to contribute to a more enjoyable visiting experience. We found it was important to carefully balance these two, so that the whole experience doesn't degrade, i.e. too much learning contents and/or too much fun without learning. Having this in mind, results suggest that the interactive virtual book was the most effective for learning about the exhibition's cultural contents. However, these contents varied somewhat (although they were very similar in terms of apprehension difficulty), and this means that any comparison is difficult to be accurately made. Overall, the significant conclusion was that, above all, we made no harm. Or to put it differently, we tried to make sure that technology would not be a distracting factor from learning.

## 5 Conclusions

One of the main problems we face today, when trying to provide museum experiences incorporating interactive technologies, is to find out issues that could guide future designs: in this paper, we learned, for instance, the importance of affordances and clues, i.e. the importance of showing museum visitors that they *can* interact with screens and floors, since people aren't still used to this kind of interactive technologies. During the transition to experience design, the HCI community needs to consider many new perspectives on how interactive technologies can bring value to museums and cultural heritage events and exhibitions.

A great difficulty arises when the final product is actually deployed: interactive installations are difficult to prototype and many aspects are actually impossible to



model and test by means of early prototypes: sometimes even the color scheme of the projector, as well as surrounding lighting conditions, caused changes in the digital contents. This doesn't happen with, e.g. mobile applications, where the designer has full access to the end product's look & feel anytime and anywhere.

Interactive, real-world exhibitions like this one provide a fertile playground for studying HCI techniques, and for delivering cultural contents to the new "digital natives" as well as to the "digital immigrants" [12].

Some days prior to the exhibition opening, the installations were presented to a group of museum experts, who showed great acceptability towards new digital technologies like these. They were able to explore the interactive installations with care and reported that the interactivity provided an interesting level of engagement. More importantly, several schools visited the exhibition and young students were drawn to the interactive technologies, demonstrating a discernible increase in motivation for learning in the exhibition, as measured by their increased time in the museum and by their informal comments during the interviews.

Despite the challenges and difficulties, we have shown how powerful technology can be, when it comes to digitally augmenting the museum experience.

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