



Increasing the Museum Visitor's Engagement Through Compelling Storytelling Based on Interactive Explorations

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Abstract. Today, technology offers exciting and news possibilities to bring visitors closer to museums. The museological universe has developed a lot over the last years, presenting today with innovative characteristics thanks to the digital realms, losing the characteristics of traditional and static museums. As a result of this development, the requirements of visitors increased.

In this paper, we introduce a new approach to making the visitor experience more immersive and engaging. We present “StoryWall”, a tangible user interface. We created a sensorial experience by presenting the content through touch, vision, and sound. As the main contribution to HCI in museums, we report on the utilization of this interactive installation as a case study.

Preliminary results bring important design implications for this context: how can one develop and implement innovative technology in museums without disturbing the traditional environment and other constraints? We also report on how designers can balance the impact brought by technology in museums and ways to inspire exploratory behaviors as well as promote collaboration among visitors.

Keywords: Interactive museum · Visitor experience · Interactive wall · Tangible user interface · Interaction design

1 Introduction

The use of ambient technologies in different contexts has been vastly increasing over the past years, as these technologies allow for new ways of creating and sharing meaning, as coined by Dourish’s seminal work on embodied interaction. New ways of interacting with objects and spaces through interactive systems have been widely used in order to deliver more innovative experiences. In museums, engagement has been recognized as a key driver for improving visitor’s satisfaction levels. A new series of technologies are being deployed and evaluated in museums, and interactivity in museums is, therefore, maximizing the physical and real experiencing, offering a more engaged and rich learning experience [1]. Throughout the development of this project, we the use of ambient technologies in different contexts has been vastly increased over the past years, as these

technologies allow for new ways of creating and sharing meaning, as coined by Dourish's seminal work on embodied interaction. New ways of interacting with objects and spaces through interactive systems have been widely used to deliver more innovative experiences. In museums, engagement has been recognized as a key driver for improving visitor's satisfaction levels. A new series of technologies are being deployed and evaluated in museums, and interactivity in museums is, therefore, maximizing the physical and real experiencing, offering a more engaged and rich learning experience [1]. Throughout the development of this project, we worked closely with the museum manager to identify the main problem points, which are as follows: communication barrier between museum collection and visitor, little information about the sugar manufacturing process and the loss of historical references in the present generation, of the lack of connection (communication) between the museum collection and the visitors that was one of our main motivations. Therefore, our goal was to construct an object (see Fig. 1) that would help minimize the impact of problems encountered through touch, sight, and sound. In this context, we present "Open Sesame", a new tangible user interface that aimed at joining the rich history of Madeira Island (Portugal) in the 15th century, using a "StoryWall". This interactive installation uses BareConductive's Touch Board Starter Kit to implement a wall where visitors interact and actuate digital content. The goal of the approach was to improve learning and promote a more engaging experience to the visitor, bringing a more immersive feel to what would otherwise be a conventional museum featuring artifacts from sugar cane factories of the 15th century. In this article, we start by discussing examples of interactive museums, then describe the whole process of system implementation and prototype construction. Finally, we explain the evaluation to which the project was submitted.

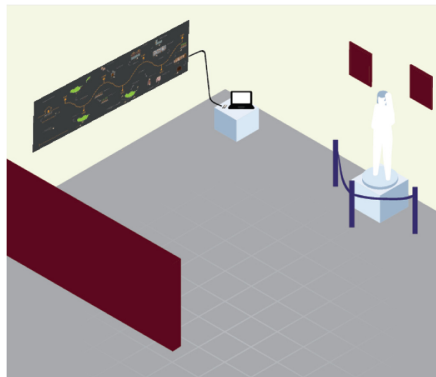


Fig. 1. Vector layout of the interactive installation in the exhibition hall of the museum "A Cidade do Açúcar".

2 Interactivity in Museums

Technology today provides exciting new possibilities for creating more appealing museum experiences, since we can exploit the surprise factor of innovative interaction styles to create an engaging experience that facilitates the learning process [1]. The traditional image of what a computer system is - screen, keyboard and mouse - is changing due to the development of technology incorporated in the real world and this technology allows the user to use their own senses. It is because of these technologies that there are opportunities to create new forms of interaction based on body movement and manipulation of real objects. Museums should seek to bring technology together to capture visitor's attention, evolving interaction design and usability, because incorporating exhibits, objects, interactive installations and people into a network of interconnected systems is a difficult and challenging task [2, 3], given the many factors that make them more attractive and why it is challenging to introduce technology into museums without disturbing the environment.

Interactive installations have grown in the museum world because they have become a support for enhancing the visitor experience and demonstrate their potential to enhance the information contained in exhibitions while educating the visitor.

For example, *The Fire and The Mountain* [4] is a project in which four digital touchable installations at the Civic Museum of Como (Italy), support tangible interaction and integrate text, video and sound. This project supports what was previously mentioned about interactive installations in museums, as the main objective was to improve the level of learning and understanding about fire culture.

Another example, the *PuzzleBeo* [5] is an interactive installation implemented at a public maritime museum in Ireland. The installation is comprised of interactive jigsaw, projected motion graphics, sensor technology and multimodal feedback. The focus is on simple interaction through touch, social interaction and learning, because this project presents the story of the sailing and sinking of the RMS Titanic.

Dória et al. [6] developed a project that consists of fifteen sensor-based interactive installations on the endemic forest of Madeira Island, another project in which the focus is on the adopted styles of interaction.

3 Open Sesame

3.1 Design Goals

According to Horn et al. [7], tangible interfaces must be inviting and easy to understand, besides, they must maintain the attention and motivation of the visitors throughout the interaction process. Therefore, we used the five design goals for user interfaces in museological environments to develop our prototype.

Inviting - Interactive installations need to attract the attention of visitors and invite them to interact with them.

Apprehendable - Visitors with no previous experience of interactive facilities should be able to easily learn how to use them.

Engaging - An interactive installation strives to hold the attention of several visitors throughout the exploration process.

Supportive of Group Interaction – Interactive installations should support social learning and group interaction with both active participants and passive observers.

Inexpensive and Reliable - As museums are non-profit institutions and depend on the support of foundations among other supports, the idea is to keep development and maintenance costs low.

We developed the design of the interactive installation based on the design goals and based on the design principles applied in previous works [4].

Emotional Evolvement: Where we make the visitor experience more enjoyable, more engaging, and more meaningful.

Multi-Modality: We support different sensory modalities and involve multi senses: touch, hearing, and sight.

Discovery Learning: We can expose visitors to a variety of content by promoting discovery through direct interaction with the facility.

Social Learning: supporting learning as a social process and fostering mutual collaboration and group discussion.

3.2 Design Rationale

Starting on the theory previously presented, we developed “A Journey in Time”. The installation that composes “A Journey in Time” integrates text, icons, videos, and sound. We designed a narrative flow throughout the installation so we developed the timeline (see Fig. 2) so that visitors could understand the whole narrative.

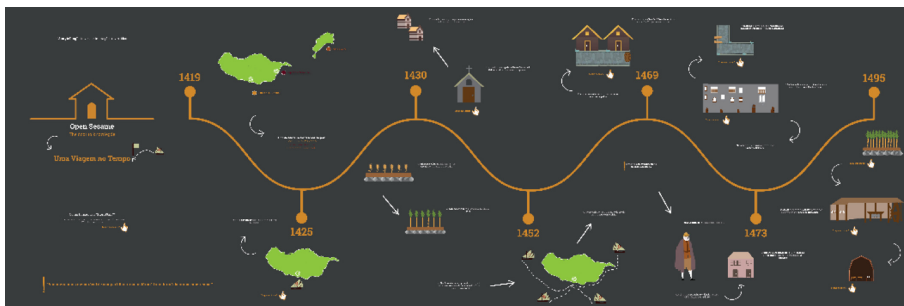


Fig. 2. Interactive installation design

The videos were grouped by themes, a total of eight videos. Three are in 2D and five videos in 3D. The idea was to adopt gestures that people are familiar with in real life so they can watch the videos. Each video is associated with an interactive installation icon, the visitor touches the icon and plays the corresponding video.

The first video demonstrates the discovery of Madeira Island, the second video explains how the settlement was made and the third video how the island developed (see Fig. 3A). These 2D videos have a simple language, based on moving icons.

The 3D videos help minimize the lack of information on sugar manufacturing and 15th century market life. The sugar manufacturing process is grouped into three videos.

The first video explains sugarcane harvesting, the visitor can view a sugarcane field, slaves and animals. The second video and the third video demonstrate and explain how the sugarcane juice was extracted and how the sugar was obtained (see Fig. 3B).

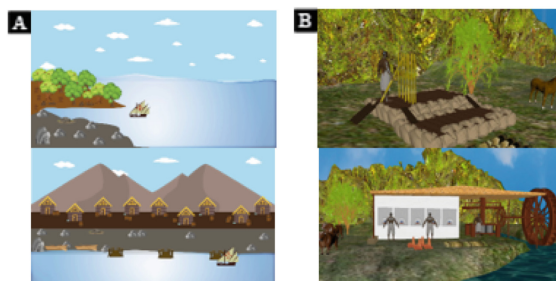


Fig. 3. A) 2D videos frames B) 3D videos frames

The last theme is about the 15th century civil architecture, we built the exterior and interior of a typical century house (see Fig. 4A) and the street environment (see Fig. 4B).



Fig. 4. A) 3D video frames B) 3D video frames

3.3 System Implementation

The prototype was developed using a touch board, conductive ink and crocodile clips that are part of the Bare Conductive Touch Board Starter Kit, a computer, a projector and interactive installation (see Fig. 5). We developed a StoryWall through projection mapping using the touch board. We then use conductive ink to create sensors across the cardboards, painting the conductive ink to the edge of the cardboards and then attaching the crocodile clips to the ink and touch board. When visitors touch the interactive surface, the software triggers digital content, that is, videos, which bring the wall to life, creating a surprising and engaging experience.

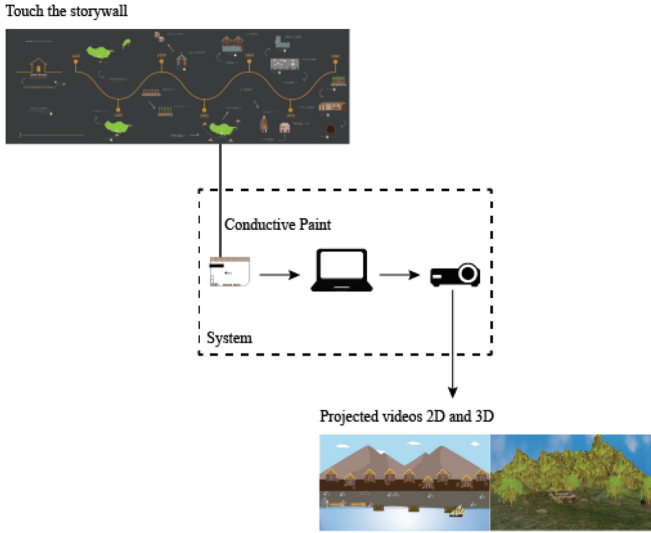


Fig. 5. System architecture

4 Evaluation and Results

4.1 Self – evaluation System

We carry out this assessment because there is a wide range of issues to be assessed in the interactive installation, our goal was to detect usability errors before testing with users (visitors) in order to minimize the impact of errors at the time of testing.

We have submitted our interactive installation for evaluation based on the M-Dimensions framework [8]. This framework was developed by a team of researchers in 2012 to evaluate and compare interactive museum installations. The framework was coined “M-Dimensions” (M stands for Museums) and is composed by ten dimensions (interaction style adequacy, area integration, visibility, feedback, structure, reuse, simplicity, education, entertainment, collaboration), which are evaluated individually by a 5-point Likert scale (1: very weak, 2: weak, 3: reasonable, 4: good and 5: very good score). The goal is to rate each dimension, sum the scores and, finally, divide by the number of dimensions being considered in a specific interactive installation. The result is a final evaluation score between 1 and 5 that is meant to convey the level of the interactivity quality that is present in a given museum interactive installation. For example, if the final result of a specific installation is 1, we can state that the installation is interactively very weak. On the other hand, if the final result of the evaluation is a 4 or a 5, we can assert that the specific installation is good (or very good) in terms of interactivity (Table 1).

As a result, we have to improve the feedback that the system provides to the user and the collaboration between users, it was the parameters that had the lowest scores.

Table 1. M-Dimensions framework applied to the prototype – “A Journey in Time”

Dimensions	Installation	Explanation
Interaction style adequacy	5	A simple and appropriate interaction style (touch) is used, the visitor can control the content viewed
Area integration	5	Prototype was implemented and tested in the museum “The City of Sugar”
Visibility	5	The font style used is readable, all relevant information such as timeline dates are displayed. There is indication on how to enable digital content
Feedback	4,5	The digital displays installation content change but does not indicate when it finishes
Structure	5	The quality of the elements is good, and all follow the chronological order
Reuse	5	Elements follow a pattern and are reused throughout the installation
Simplicity	5	Using the installation is simple, the visitor must follow the dates and the installation indicates where to touch
Learning	5	Appropriate and simple learning content (historical facts) increasing the level of education
Entertainment	5	Digital content is tractive and achieves a greater sense of immersion
Collaboration	4	Only one visitor can use the installation at a time, but we come across multiple visitors

Final Result: 4,85 (Good)

4.2 Collection of Users Tests Data

The museum “A Cidade do Açúcar” authorized the implementation of the prototype and because of this we can perform an *in-situ* evaluation, but due to the limited space, the tests were performed in a support room. The participants were chosen considering the most frequent audience of the museum. A total of 10 participants, 6 females and 4 males, aged 18–32 years ($M = 23$, $SD = 4.4$), over 2 days tested our project, underwent observations while interacting with the prototype and then responded to a questionnaire. After the evaluation process, all participants received a flyer with information about the project.

Observations. Observations were performed *in-lock*, we recorded observations through notes and photographic records. During the observations we kept a certain distance so as not to intrude on the interaction between the user and the interactive installation, we started by recording if the interactive installation aroused curiosity, then observing how the user interacts with the installation and how long the interaction lasts.

Questionnaires. The main objective was to gather quantitative data based on visitors' specific opinions by submitting a questionnaire after interacting with the interface. We grouped the questionnaire questions into three groups, according to the themes under analysis: I. Interaction with the installation/II. Presented Content (Videos)/III. Personal Comment.

4.3 Results of Users Tests

The test results with users came only reinforce the results obtained in the self - evaluation performed.

Observations Results. Overall the time of observation was between 7–17 min. Users did not have read order because they did not follow the timeline but read all the information contained in the interface. They watched each video to the end and reread the information and see the icons (see Fig. 6).

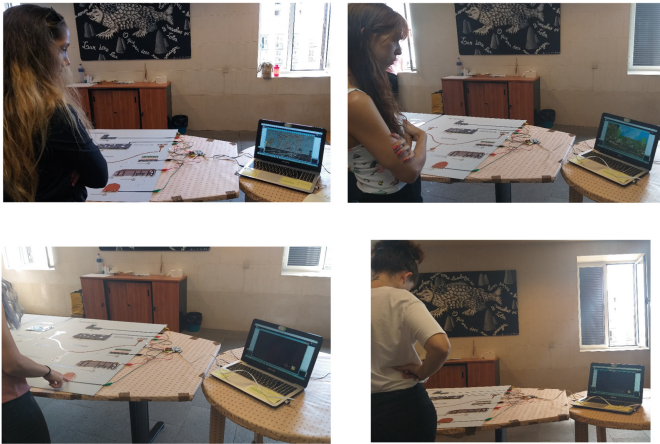


Fig. 6. Photographic record of some users testing the prototype

In this evaluation, we detected usability errors, such as the lack of indications along the timeline because for us it makes sense but for the visitor who doesn't know how to make it difficult and the order that the videos follow to be able to tell the story.

Another problem detected was that the distance from the ink to the touch card that is connected to the computer made it a problem because there is a break in communication due to the distance. In this case, some videos didn't work at all. And a system error that we detected, it is necessary to restart the system if the visitor wants to view the videos again.

Questionnaires Results. Questionnaire with a total of 12 questions in which 11 questions are evaluated by a Likert 5-point scale (very poor, poor, fair, good or very good).

First group of questions, participants answered questions about the difficulty they felt interacting with the prototype, whether they found the interaction motivating, whether the prototype is interesting (appealing) and whether it is creative.

In general, the installation is easy to use, appealing and creative.

The second group of questions is about the content presented, the icons and the text of the physical installation and the digital content, the videos in 2D and 3D.

According to the general opinion of the 10 participants, they found the content relevant because the icons and the text had a simple language and the videos were attractive.

In the last group, we asked the participants to describe their personal opinion about the prototype, the opinions of all participants were similar, "creative design", "historical context relevant to the knowledge of island history", "simple and intuitive interface", "interesting idea". Although participants mentioned positive aspects, they also described some fewer positive aspects, "interesting idea, but would like to have tested in the museum environment" and "different ideas, but the icons to touch are confusing".

Initial feedback shows that participants were receptive to the use of innovative technology in the museum.

5 Final Considerations

5.1 Conclusions

In this article, we present Open Sesame, a tangible user interface that is the communication link between the museological estate and the visitors to the museum.

We believe that with the implementation of this prototype we were able to transmit the missing information. It should be noted that this project is still in the development stage because, during the tests carried out, we encounter some errors in the system.

It is a project with innovative technology. The development of 3D elements can become an asset and enrich the project due to the impact it causes because it becomes so real and disseminates information using videos with sound and animation captures the attention of visitors.

5.2 Future Work

For future work, we have to solve the usability and system problems that were detected throughout the observations and In the future we intend to carry out additional assessments to better understand the visitor's learning and engagement process during their visit, to carry out a visit without the tangible user interface and another visit with the tangible user interface. Thus, we will obtain the results that justify the greater use of these technologies in museological environments.

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