Design of an Interactive Experience Journey for a Renovated Cultural Site at an Abandoned Textile Factory

Charissi Elli, Gaitanou Maria, Margari Iosifina, Papamakarios Manolis, Spyros Vosinakis, Damianos Gavalas, Panayiotis Koutsabasis, Modestos Stavrakis

University of the Aegean
Department of Product & Systems Design Engineering,
Syros, Greece

{dpsd14120, dpsd14015,dpsd14058, dpsd13132, spyrosv, dgavalas, kgp, modestos} @syros.aegean.gr

Abstract. In this paper we present the design of an interactive experience journey at an ex-industrial textile factory. The aim is to enhance visitor experience by engaging them in the work processes and flows that were taking place in the actual industrial environment and introduce them to the role of the artifacts and tools involved in real life work scenarios. The development is of the form of a room escaping experience developed on the basis of riddle solving. We used a number of technologies related to interactive systems design such as near field communication, beacons, physical computing, sensors, actuators and tangible artifacts.

Keywords: interactive tour, escape room, interactive systems, physical computing, tangible interaction

1 Introduction

Heritage, tourism and entertainment are a constantly growing sectors currently focusing in the incorporation of interactive technologies for engaging people in rich experiences. In addition, a phenomenon which has grown in popularity in recent years, called "room escaping" gained audience attention by gaining special attention by those seeking excitement and fun and at the same time want to participate in an active learning experience [1].

The concept of the actual escape room is not new. Although initially it has been neglected to a large extent by the research community, recently there is a growing interest both among researchers and developers as well as an increased appeal to the general public [2]–[4]. Real-life escape rooms are live-action adventure games, where the players are organized in groups of two or more people, locked in a room or in a series of rooms, from which they must escape within a pre-defined period [1]. To find their way out, players must solve a number of different puzzles, search for clues and objects scattered in the room and use them to complete specific tasks. Escape rooms are not simply a fun way for players to spend time with their family, friends or colleagues, but

more importantly they provide an opportunity to develop organizational and communication skills as well as nurture critical thinking and creativity [2].

In this paper our primary goal is to create an interactive, educational and collaborative experience for the visitors of a newly renovated cultural space of an previously textile factory (Zisimatos Industry) that has been abandoned since the 80s (1986). The purpose is to create an escape room experience by using interactive technologies based on physical computing and tangible interactions and thus engage the visitors to different scenarios that involve riddles related to the original industry's work processes.

Objectives of this work include:

- Educational: highlight the history of the textile industry & the history of the actual textile factory.
- Experience: develop interactive experiences for the visitors.
- Social engagement: Cultivate the sense of cooperation, teamwork and critical thinking.

Fig. 1.Overview of the Zisimatos Textile Factory

1.1 Industrial cultural heritage and the textile industry of Syros

In the 19th century, Hermoupolis was one of the largest financial centers in Greece, due to the development of shipping and commerce. After the crisis that the local economy suffered due to the expansion of the steamer boats, Syros was no longer a transit center. Cotton-producing industries saved the city from its financial decline. The cotton-industry was rather extensive encompassing all aspects of cotton manufacturing (yarns, fabrics, facings, socks, handkerchiefs, cloths) [5]. The island's cotton-plants had a workforce of more than 5,000 workers and were able to meet a significant proportion of the country's needs in cotton. The plants produce was also successfully exported abroad.

1.2 The industrial heritage site: Zissimatos Textile Factory

In 1950, following the dissolution of the company, a commercial & industrial company under the name "G.ZISIMATOS & SONS" was fully renovated and enriched with cutting-edge European equipment used for the production of cotton socks, for men, women and children. In 1960, the factory stopped the production of socks, was renovated again and with the new machines began the production of towels, bathrobes etc. in a wide variety of designs of excellent quality. These products were distributed throughout Greece. The factory had a total power of 167 HP, 19 double looms and 40 workers. After its financial decline in the beginning of 80s, the operation of the factory ceased smoothly in 1986. The factory buildings, complete with their machinery and the leftover tools and equipment used at the time of closure, remained locked since 2017 when the new owner decided to renovate them as an industrial cultural heritage site.

2 Methodology

The design methodology followed an iterative design approach and included close cooperation with the curator and coworkers, as well as in-situ observation and interviews. This design approach was followed for the development of the interactive tour and it can be described with the following intertwined phases.

Research and inquiry (R&I). This phase concerns the research that had to be conducted. This stage lasted 5 weeks and included research on the cognitive background, some indicative related work, research of the escape room target group and research on similar technologies.

Design and prototyping (D&P). This phase included an eight-week-long design phase, including designing the tour, choosing the technologies which fitted best our project, designing the prototypes and the riddles.

Evaluation and testing (E&T). This phase of the project included the process followed for conducting the assessment of a low-fidelity prototype, the objectives, the selection of the participants, the results obtained from the evaluation and the final conclusions. It took place in the lab and at the actual site.

3 Research

3.1 Research on Designing Escape Rooms

Escape Rooms constitute a new kind of entertainment that has evolved from role-playing, live treasure hunt, and online escape halls where players try to release an avatar by solving puzzles [2], [3].

Many different types of escape rooms are available in various facilities around the world with design concepts varying significantly. Depending on the escape room, players resolutely solve puzzles, that may be spatial, mechanical, linguistic or mathematical. A survey completed in owners of 175 escape room facilities around the world found that 13% had an open model where players solved puzzles in no particular order, 37% had a sequential pattern where the puzzles were drawn in a linear sequence and 45 % had multiple sequential paths [2].

Escape rooms are similar to "pervasive games" that move beyond computers to take place on mobiles or other interactive devices. Alternative Reality Games (ARGs) is another type of diffuse game that combines gameplay with real life, often as a form of online storytelling [6]–[9]. Escape rooms follow the same concept and include a theme that bridges real life and an alternative reality, though undoubtedly to a lesser extent than a game of alternative reality. Cooperation in such contexts has been studied in several of these games and in general, these games focus on developing trust amongst strangers [10], [11] by creating and exploiting the sense of community [12]–[14]. Relevant research has indicated that co-operation can help players learn [15], create a common understanding, increase the motivation of players and raise concerns for society and technology.

Researchers have also studied social presence and feelings during the game. Studies have shown that social presence (in-situ presence) is higher when people play against their friends compared to strangers or computer opponents [16], [17]. Feelings of strong social presence have been associated with user satisfaction and higher levels of stimulation have been associated with playing with a close friend [18]. Higher levels of social presence can be achieved amongst distributed players when working for a common purpose [17], [19].

3.2 Related Work

In this section emphasis is given on state-of-the-art technologies and related projects. They refer to works implemented for interactive museums and technologies that make the experience of the visitor more interactive.

Interactive museums include “Sheeptag: An Interactive Museum Exhibition” a Tangible, Interactive Exhibition for Museums, held in the framework of a thesis in Computer Science and Product Design at the University of Aarhus, 2011 [20]. Sheeptag was put on a permanent exhibition at the Naturhistorisk Museum in Aarhus. The aim of the interactive installation is to assemble the skeleton of an animal by using tangible objects, microcontrollers and a computer application. Each bone has a small RFID tag embedded. The placement of the bone above the red circle indicates the bone in the sheep image on the screen. Also, the corresponding human bone is indicated.

The “Mystery Tour Athens” is another project that features the adventure features of an escape room, but transferring players to the center of Athens. Thus, the possibility of discovering important aspects of the historical monuments of the city is provided. To complete the journey to the historic center of Athens, each member of the team is provided with equipment, which also includes an electric vehicle [21].

Technologies that influenced our work include “iPhone RFID Object-Based Media” a prototype of an iPhone media player that uses RFID embedded in physical objects to control media playback [22]. SKÅL is a media player designed for home use that allows the interaction with digital media using physical objects. Interaction takes place by placing different objects in a wooden bowl. The wooden bowl then recognizes the different object, and plays different kind of movies in the TV [23], [24].

3.3 Target audience

Escape rooms are suitable for a wide set of people. According to research about 37% of the teams are made up of groups of players over 21, about 14% of the players are families with parents and children, while 19% are groups of players under the age of 21. Corporate customers account for about 19% of escape rooms and 11% of teams are couples. What is also interesting, is the results considering the players’ gender. Unlike some forms of gambling, escape rooms have drawn players of both sexes. About 70% of the teams are mixed and the other groups are equally distributed amongst males and women.

3.4 Technology Research

We researched a number of technologies including NFC/RFID tags and Beacons for the tokens and the proximity sensing, physical computing platforms, sensors and actuators. NFC/RFID tags were considered for the tokens that we needed to identify the various objects. Beacons used to locate objects in space and identify their relative position with the user while physical computing was the basis for constructing interactions, sensing of the environment and providing system feedback.

For the purposes of this project we used a number of the aforementioned technologies. For the reader we used an Arduino board along with an NFC reader, a buzzer and 2 LEDs used for item recognition. For the interactive table, a second Arduino and another NFC reader with a number of NFC tags for every different object.

4 System Design

The design of the system was divided in five main phases including, the design of the experience journey, the riddles, the workbooks, the interactive technologies and the design and construction of the case of the interactive table.

4.1 The Design of the Interactive Experience Journey

The interactive experience journey was based on the actual production flow of the factory and the order in which the various workstations and tools were arranged. Based on interviews with people who worked in the factory at the time of its operation and desktop research we did in the lad we recorded the actual processes and workflows. For our purposes we distinguished five of the most significant production stages that were representative of the production flow. Based on those we designed the corresponding workbooks and props of the actual workbooks the factory employees owned and used daily. We also designed a distinctive artifact that represented an object/tool for the job.

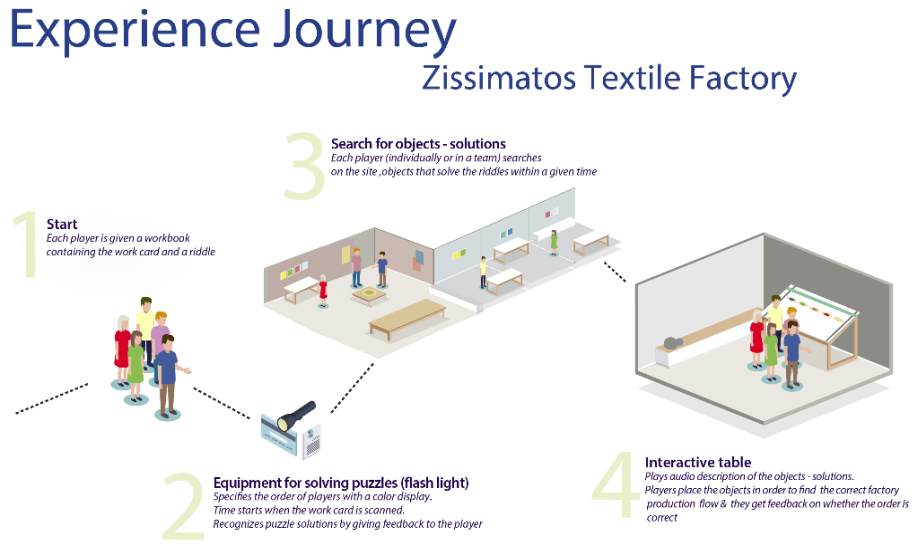

Fig. 2. Experience Journey Mapping of the Textile Factory

4.2 Riddle design

The next stage in the design process was the design of the riddles according to the respective workspace and its historical information. Initially we chose an specific answer that the riddle must conclude with, we brainstormed a number of possible related concepts, we drafted the riddle in terms of metaphors related to the possible concepts of the previous step, and used language techniques such as alliteration and rhyme to make the riddles easier to tell and remember. After designing all riddles, we evaluated them with a group of random students that did not have any specific knowledge regarding the textile industry. The purpose of the evaluation was to understand how difficult or easy the riddles were. In the cases that the participants could not find the right answer, photos from the workspaces were provided so that they could better frame the concept. After the evaluation, changes were made to 3 out of the 5 riddles.

4.3 Workbook design

For the design of the workbooks, as a reference, we used the real workbooks that have were used in the factory. The same structure was retained, as far as the data of each worker were concerned, but added elements that were essential for the game. Such elements included a map with the indication of each workplace, the riddle, some basic instructions, and the employee card.

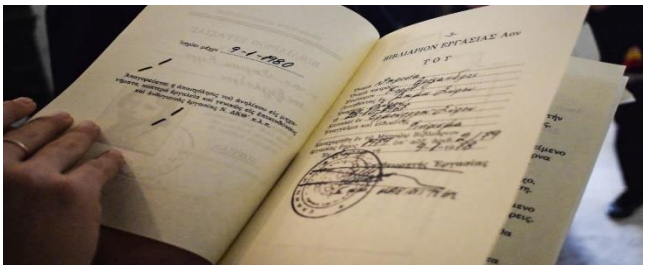

Fig. 3. Player looking through the workbook

4.4 Prototyping the Interactive Table & Torch

Our system was comprised of two main components, an interactive table and the tangible torch.

In order to produce a low fidelity prototype for the Torch - the object which is used to scan items and which indicates if an item is the solution to a riddle - we designed a torch using Creo Parametric, and then we printed it in a 1: 1 scale, in 4 separate pieces. Then, the pieces were glued together. The Torch was designed as a shell, so we had enough room to place the Arduino and the corresponding reader for the NFC Tags inside it. On top of the Torch, 2 holes of adequate size were created to place the LEDs. These 2 LEDs- a green LED and a RGB one - were used to provide the players with the needed information. The green LED indicated that the player was scanning the right object, and the RBG LED, which showed the colors red, green, blue, yellow and pink, indicated the random sequence of the players.

The final station of the tour was the interactive table. In this table, the players, after having solved all the riddles and collected items, could "scan" their objects, hear their stories and how they were used in the production flow. Finally, the players were asked to place the items on the table, and scan them again, this time with the order they think the items were used in the production flow. If the players managed to find the right order of the items, a hidden room was revealed to them and they got to explore it and learn more about the history of the factory.

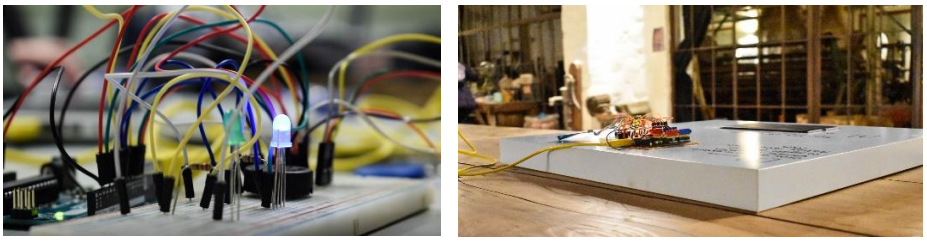

Fig. 4. The electronics of the torch prop (left) and the interactive table (right)

5 Evaluation

For the evaluation, user testing methods were applied, using a low-fidelity prototypes, installed at the actual site of the factory. These included on-site observation, video observation, interviews and questionnaires.

Fig. 5. Player during the process of Evaluation

The objective of the formative evaluation was to obtain useful feedback from designer participants and thus to extract useful feedback with regards to the usability of the system. The evaluation metrics focused on the identification of usability problems, and the overall user experience.

The same procedure was followed for all groups of participants of the evaluation. Initially, some basic information was provided on the design of the game and the use of booklets along with hints about the procedure for recognizing objects. Then, the team entered the evaluation area and each player started playing autonomously by following the scenarios related to their profiles. When all the players of the team had solved their riddles, it was time to move to the second part of the game, the table. Next, the players had to scan their items, listen to "story" related to their profile and the production flow they were assigned to. In the following step the participants were prompted by the system to scan the items in the order they thought these fitted the production flow. At this point, the players had an unlimited number of retries in order to find and solve the riddle. Finally, in the case they found the right order, they "unlocked" the hidden room with the actual knitting machines which they could also closely examine.

To collect data, we performed on-site observation where we watched and held notes about the navigation of players as well as how they interacted with the game. We also captured the whole evaluation process in video and later did a video observation analysis in order to identify participants' movements and actions. We also given usability related questionnaires at each evaluation session to all the participants. At the end of the session with the expert participants (professors, designer students) we also performed short interviews in order to collect recommendations about improvements and changes to the prototype.

5.1 Participants

For the purposes of the evaluation we created 4 groups. The first two group had 5 and 4 participants, of ages between 21-23 years old (students) and 28-32 (citizens) repsectively. All participants had previous experience with the technologies involved but they had no background about the historical content related the industrial site. The third group consisted of 4 participants (course professors) also familiar with the technologies and partly informed about the historical content, the cultural background and the processes and workflows of the factory. Lastly, the fourth group consisted of 5 people identified as "escape room enthusiasts" with special interest in participating in escape rooms for solving riddles. They were partially familiar with the technologies used and unfamiliar of the content and other data related to the site.

Fig. 6 Player trying to solve her riddle – On the right hand she is holding the Torch while on her left hand she is holding her workbook.

5.2 Results and conclusions

After processing all the responses and comments we receive during the evaluation process, the final results were drawn. The main results were as follows:

- 70% of participants (14 people), said that they collaborated with other people in their group to find the answers of the riddles, while out of these 14 people, 10 described their collaboration as "fairly good" and 4 of them as "good".
- 95,2% of the participants thought that throughout the game they were able to better understand the production flow of the Textile Factory.

- 42,9% commented that they wouldn't want to use another way to tell the story of the objects whilst the most common comments we received were the following:
- The whole process was described as interesting, educational and impressive.
- It was often noted that the process was short in duration and that there was a need for more objects and riddles per workspace.
- There was need for more indications in the recognition object, as well as more indications on the map that showed workspaces, as many participants faced problems with their navigation.

6 Issues to be improved

The key improvements that we think should be implemented in order for the interactive system to be ready for installation and use in real-time are listed below. We also included improvements that we would have made should we have more time and resources available to our disposal.

Related to the tangible torch the comments included recommendations about having a different device for every participant, they wanted them equipped with feedback mechanisms (audio and visual) for the riddle responses and the remaining time for solving the riddles. Also, recommended to have audible notifications for validation of each participant's work card and when a player scans an object (right or wrong object according to their riddle).

The interactive table was recommended to be redesigned to aesthetically fit with the factory's arrangement/configuration. Interaction with the table should happen on its surface. Technologies that will be of use would be better placed inside the table and will not be visible. The interactive table should have specific spaces for each object through which the factory production flow will be revealed.

Fig. 5. Player using the Interactive Table during the game

We also received a number of recommendations related to the corresponding post and production flows. These included the creation of more workspaces for better understanding of the factory's production flow, the creation of new workspaces to support more players, that every workspace should have more than one riddles, so that the game will have a longer duration, a gradual increase of riddle difficulty was also advised

and finally that every object should have a hint, in case that a player couldn't find the answer on the assigned riddle after a period of time.

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