Chapter 5

A 4D VIRTUAL PRESENTATION OF THE WHITE BASTION FORTRESS IN SARAJEVO

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ABSTRACT

The fortress known as *Bijela tabija*, or the White Bastion is one of the most impressive and important historical sites in Sarajevo, Bosnia and Herzegovina. It is located on the southeast outskirts of the city and offers a view over the city valley. Historically it has commanded a significant and strategic position in the city. The fortification is a part of the dominant defensive walls that surrounded the old city of Vratnik.

The historical site presents various valuable strata, from the medieval era to the present. During archaeological excavations the remains were found of a medieval fortification from the fourteenth century, and from the Ottoman period in the seventeenth century when the fortification was expanded and some new structures were built. During Austro-Hungarian rule part of the fortification and the structures inside the walls were demolished and a new group of structures was built. During the early excavation, a significant number of artefacts was found, registered, and conserved for the purpose of the exhibition hosted in the Museum of Sarajevo.

Our project "4D Interactive Multimedia Presentation of the White Bastion Fortress", described in this chapter aims to present the historical development of this cultural heritage site through digital stories combined with interactive 3D models of the Bastion in various time periods. These models include digitized findings from the site and their 3D reconstructions.

Keywords: interactive digital storytelling, virtual cultural heritage, virtual reality, 3D virtual reconstruction, COSCH

Introduction

The age of interactive communication has changed the way people perceive information. All aspects of our lives are influenced by digital technologies. They introduced a new language, and new communication means and tools. Cultural heritage is no longer limited to museums and heritage sites, but is being communicated to the public through new methods and forms which enable users to travel virtually to the past.

Storytelling has been present in human communication since the beginning of time. Our ancestors used to tell stories and tales around camp fires. Every day of our lives can be described through a set of stories. Therefore, it is natural that storytelling plays an important role in cultural heritage presentation and its digital preservation. Museum exhibitions employ storytelling to explain the context and purpose of exhibited objects, in order to make the visitors' experience more attractive. Virtual reconstructions of archaeological remains are becoming enhanced with stories about the objects, characters, and events from their past.

Digital media applied to the study of cultural heritage engage interdisciplinary teams of researchers: historians, digital humanists, computer scientists, archaeologists, writers, psychologists, and visual artists. They work together seeking the most attractive, immersive, educational and entertaining methods in virtual presentation of cultural monuments.

This chapter recounts an experience of such a quest through the 4D interactive multimedia presentation of the White Bastion Fortress in Sarajevo. The term 4D alludes to the fourth dimension, time, in a three-dimensional presentation of the object. The White Bastion Fortress has been used to defend Sarajevo since the medieval period. It has changed over time as power has changed hands in the city. 4D virtual presentation aims to display the historical development of this site through digital storytelling combined with interactive 3D models of the Bastion in various historical periods. These models include findings from the site that have been digitized and some 3D reconstructions. A new method of interactive digital storytelling for cultural heritage was implemented.

Related projects that served as an inspiration for creating the application will be presented in what follows in this chapter. Our team's research in interactive digital storytelling will be described, and a new concept implemented in the White Bastion case study will be elaborated. The details of the implementation of the case study will be offered and the first user experiences, alongside some comments, presented. The chapter concludes by summarizing the results of research and indicating future work directions.

Earlier Research

Our research into related projects focused on cultural heritage presentations which included interactive 3D models of cultural monuments interconnected with digital stories about their past. We were interested in the user experience in exploring these applications, particularly in their feeling of immersion, quality of interaction, information perception, and entertainment value.

The Etruscanning 3D project (Pietroni et al. 2013) is a virtual presentation of the Regolini Galassi tomb, one of the most remarkable Etruscan graves, and the artefacts found within it. The application is a permanent installation at the Allard Pierson Museum in Amsterdam. Thanks to its digital nature, it has also travelled around many exhibition spaces. The digital content consists of a virtual model of the tomb. The models of artefacts found in it, and currently kept in the Vatican Museum, as well as stories told by two narrators, characters buried in the tomb are also included. The content is displayed on the projection screen and users can browse and activate stories through a natural interaction interface (instead of mouse and keyboard, the user communicates with the application using gestures which are captured by a motion sensor). This project offers an interesting combination of storytelling with a 3D environment of the tomb, along with interactive models of the artefacts found therein.

Livia's Villa Reloaded (Pietroni et al. 2015) is an innovative Virtual Reality installation dedicated to the Villa Ad Gallinas Albas. Livia Drusilla offered the villa as dowry to the Emperor Augustus when she married him in the first century BC. The installation introduces a novel approach to storytelling, combining different media and languages: real time exploration, cinematographic paradigms, use of real actors, and virtual set practices. Users may select different digital stories placed inside an interactive 3D reconstruction of the villa created from a laser scan of its archaeological remains. The communication within the application is through a natural interaction interface.

The European Virtual Museum Transnational Network of Excellence (V-MusT.net) has been researching and synthesizing the knowledge on digital cultural heritage for four years (2011–15). In their final exhibition, Keys to Rome (Pescarin et al. 2014) they showcased virtual reconstructions of Roman heritage in four geographic locations—Rome, Amsterdam, Alexandria, and Sarajevo—at the same time. The aim of this multimedia exhibition was to present life in various parts of the Roman Empire during the era of Emperor Augustus. It was created through a combination of physical exhibitions from four selected museums and digital content, connecting all four locations through online virtual heritage applications. One of the setups, called Admotum, was designed as a serious game where the visitor, through a natural interaction user interface, could walk around the virtual

models of buildings from the Roman period in his or her location, while following the stories about objects from those buildings. The virtual models of museum artefacts were of archaeological finds. After successfully collecting all the objects in his or her location, the visitor could visit the other three locations of the exhibition, collect the objects there, travel "through" their monuments, and learn about them from digital stories. The educational potential of digital technologies applied to cultural heritage, together with the effectiveness of mixing up museum collections and technological applications, is presented in Pagano and Cerato (2015). The authors focus on the Keys to Rome exhibition held at the Imperial Fora Museum in Rome.

The virtual cultural heritage application setup in the Civic Museum of Schifanoia in Ferrara (Incerti and Iurilli 2015) presents the historical development of the Schifanoia Palace through virtual models of the palace in various periods. They are combined with narration about the main events that took place within and around it. The aim of the project was to enhance the experience of visitors through new communication strategies and tools, making the museum experience more complete and satisfactory.

The first three projects mentioned in this section facilitate communication between users and digital content through natural interaction interfaces. We consider these interfaces extremely suitable for museum installations, but not entirely appropriate for online implementation. The fourth project is also set up in a museum. In our project Internet access was needed for the virtual presentation, so the visitors could be independent from the physical location. Nevertheless, the experiences presented in the descriptions of those projects were a valuable foundation for the implementation of our case study.

COSCH Case Study of the White Bastion: Description of Work

Interactive Digital Storytelling

Scholarly research and experience from various virtual cultural heritage applications show that storytelling needs to be incorporated in these presentations. However, there is still no universal methodology to tailor digital stories scenarios and no implementation which satisfies all the various categories of users.

Our research into digital storytelling for cultural heritage started with the virtual reconstruction of the church of the Holy Trinity in Mostar (Hulusić and Rizvić 2013). In this project we introduced a live storyteller telling stories about the church destroyed during the war in Bosnia and Herzegovina. He was recorded against a green screen and subsequently incorporated into an interactive 3D environment. We also implemented digital storytelling in our Isa bey's endowment project (Rizvić et al. 2014), where we virtually reconstructed destroyed objects

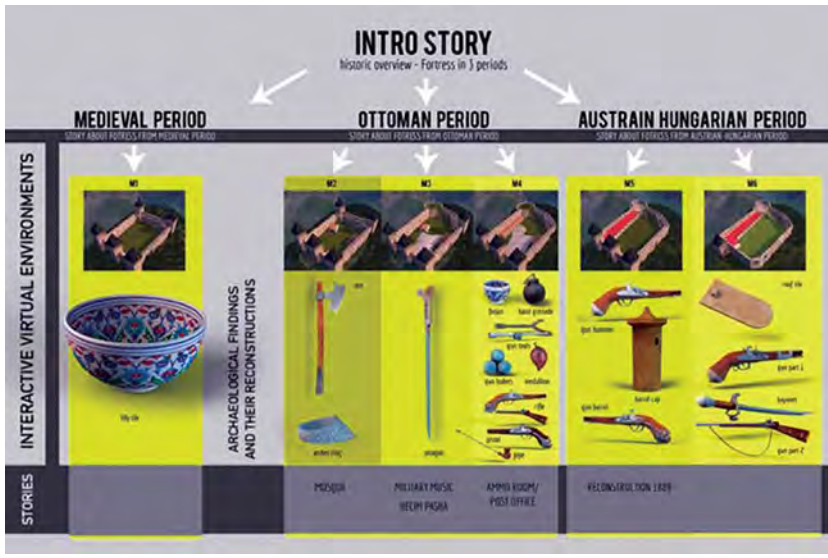

Figure 5.1. Structure of the virtual presentation.
Screenshot of the White Bastion interactive application, 2016.

from one of the first endowments in the history of Sarajevo. The computer models of these objects and audio-stories were implemented in a single interactive virtual environment (IVE). The stories start when the user approaches a particular object within this environment. A part of that application consists of an interactive computer animation of a traditional dervish ritual, which used to be performed in one of the reconstructed buildings. A dervish is a member of one of many Muslim ascetic orders. Some perform whirling dances and ritual prayers in acts of ecstatic devotion. The user of the IVE is virtually placed in the middle of the ritual. He or she may select particular participants and objects, with a click, and start stories about them. This way we introduced interactivity in our storytelling, which proved to be attractive and engaging for the users. Interactive digital storytelling in various forms was also implemented in our Virtual Museum of Sarajevo Siege (Sarajevo Survival Tools) (Rizvić et al. 2012), where a digital story guides the visitor through the exhibition, as well as the Virtual Museum of the Bosnian Institute (Sljivo 2012), where the audio stories increase the immersion of the virtual visitor into the collection.

Another methodology to which we have arrived in the course of our research takes into account the present digital communication concepts. Users tend to watch movies for no longer than several minutes. They also like to have some idea of the structure presented in advance, such as the display within HTML pages which they are used to seeing. Therefore, we divided our story into units, or substories, and offered the possibility of watching them on demand, after the user

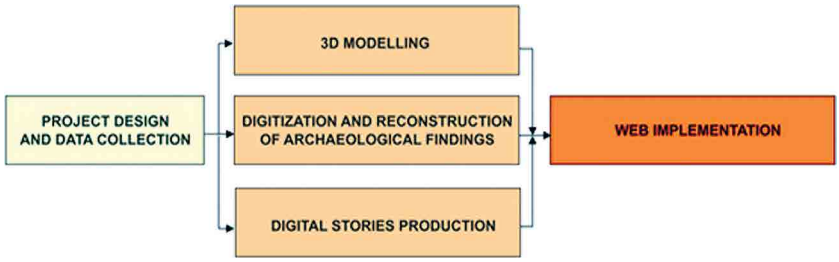

Figure 5.2. The 4D virtual presentation of the White Bastion project workflow.

is introduced to the content of the story. This concept was implemented into our Taslihan project (Rizvić and Prazina 2015). The project presented the largest inn in Sarajevo during the Ottoman period, of which only one wall is still standing. The project was implemented in three forms: a documentary, an interactive digital story, and a serious game. The final two implementations are sets of interconnected sub-stories and the interactive 3D model of the object.

In the White Bastion project we created a different combination of digital stories and interactive 3D environments. The structure of the project is shown in figure 5.1. The introductory story presents an overview of the site's history. The stories about medieval, Ottoman and Austro-Hungarian periods give more details of the site's transformation during these historic periods. There are also six interactive models of different phases of the fortress, with digital stories about particular objects, events, and characters from its history. There are also reconstructions of archaeological findings from the site.

This concept extends the work of the Taslihan project. Two kinds of navigation are available in both projects: from a story to the IVE, and from the IVE to the story. Our goal was to explore how users perceive these forms of communication, and whether they improve the user's immersion in the history of the cultural monument.

White Bastion Project

A 4D virtual presentation of the White Bastion was created with the aim to introduce the past of this important cultural monument to the general public through a visualization of its assumed appearances through history. Archaeologists and historians will also use this project as a foundation for their further research. The project was created by a multidisciplinary team of computer scientists, historians, archaeologists, writers, music composers, actors, translators, graphics designers, visual artists, and TV professionals. The project workflow is presented in a conceptual diagram (fig. 5.2).

Figure 5.3. Bijela tabija (White Bastion) fortress, Sarajevo, Bosnia and Herzegovina. Photo: Hakija Hadžalić, 2016.

The Site

The fortification known as the White Bastion is one of the most impressive and important historical sites in Sarajevo. It is located on the southeast outskirts of the city and offers a view over the city valley (fig. 5.3). Historically, it had a very significant and strategic position, being a part of the dominant defensive walls surrounding the old city of Vratnik, the oldest part of today's Sarajevo.

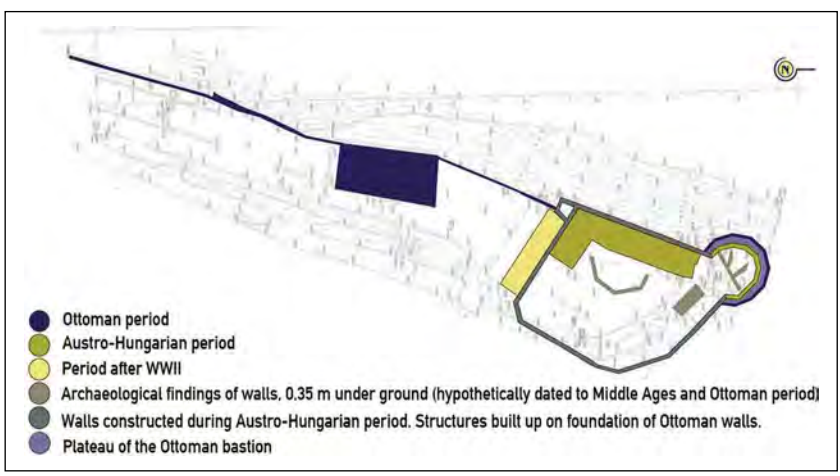

Figure 5.4. Actual state of the complex showing historical stratification. © Institute for the Protection of Cultural-historical and Natural Heritage of Canton Sarajevo, 2013.

Figure 5.5. Artefacts found on site. Photo: Museum of Sarajevo, 2000.

The significance of this historic site was manifested throughout history in various strata, starting from the medieval period until the present time. During archaeological excavations the remains of a fourteenth-century medieval fortification were found, as well as those from the Ottoman period in the seventeenth century, when the fortification was expanded and some new structures were built. During the Austro-Hungarian occupation of 1878–1918 a part of the fortification, including the mosque and some other structures within the walls, were demolished and replaced by new builds. During the early excavation (fig. 5.4), a significant number of artefacts were found (fig. 5.5), recorded, and conserved for an exhibition held by the Museum of Sarajevo.

Project Design and Data Collection

The project is designed as a collection of interlinked digital stories, IVEs, digitized archaeological findings, and their 3D reconstructions. The structure of this collection is shown in figure 5.1. Users are first offered the opportunity to watch a story, which introduces the content of the project. The stories about the three periods in the fortress's history offer more information about the particular phases in the development of the site. Users can browse six interactive 3D models of the fortress and watch the associated stories. Inside these virtual environments they will also come across reconstructed archaeological artefacts, found on the site. Clicking on them will provide more information about their context and historical significance.

The archaeologist leading the White Bastion excavation has identified six different stages in the appearances of the fortress. We based our virtual models on his

Figure 5.6. Artistic drawing of Catarino Zeno, a traveller whose travelogue is the earliest known written record of the fortress. Screenshot from the White Bastion film. © BHRT, 2016.

sketches and other input. For dimensions we used the excavation data and blueprints. The aim of the project was to raise the general public's awareness of the site. Therefore we have not implemented any modelling of uncertainty (showing with different colours or materials parts of the model according to the certainty of their appearance, so the assumptions are clearly visible). The scenario for digital stories was written by a professional novelist. He was using historic documents and sources to create the narrative. In order to increase the user's engagement in the stories he introduced a narrator. He chose for this character an eternal soldier from the fortress, who starts every sub-story with the words: "I am the soldier of Sarajevo, a prisoner of time, abandoned by death and transience." This character was introduced because we received very positive experience and user feedback concerning the digital stories told by a fictional character in the Taslihan project (Rizvić and Prazina 2015). The users said that the stories enhanced the experience of immersion and empathy with the character. We selected a professional actor to play the role of the soldier. He changed into different historic costumes, depending on the period depicted in the stories. Other characters mentioned in the stories were presented using animated drawings (fig. 5.6), as they are persons drawn from historical sources and their appearance is unknown.

3D Modelling

The first step in the modelling process was to build the terrain. In order to create a precise terrain model, the Digital Elevation Model (DEM) of the Balkans area, from

Figure 5.7. Computer 3D models of the exterior and interior of the medieval fortress. Screenshots of the White Bastion interactive application, 2016.

Figure 5.8. First 3D model of the fortress in the Ottoman period. Screenshots of the White Bastion interactive application, 2016.

the European Commission's GMES RDA project (2013) was reused. This geotiff map was then imported into Global Mapper, that is, a GIS application for reading and conversion of different spatial data sets. The precise terrain for the Sarajevo area was extracted from the map and exported as a 3D VRML file, which was then used in Cinema 4D.

Three-dimensional models of the White Bastion were created in Cinema 4D and Adobe Photoshop was used for creating and adjusting the textures. Six final 3D models correspond to the six different construction phases. The first one was in the medieval period, the second, third, and fourth in the Ottoman period, and the fifth and sixth in the Austro-Hungarian period. In order to achieve photo-realism of the renderings of the Bastion, the landscape with vegetation and the Miljacka river were added, and rendered to a high quality (figs. 5.7 and 5.8).

Digitization and Reconstruction of Archaeological Findings

Archaeological findings from the White Bastion site are housed in the Museum of Sarajevo. Most of them are not on display for the visitors to see, as the Museum does not have enough exhibition space. Our project thereby benefits the museum by providing a virtual exhibition of these objects in 3D reconstruction. Many artefacts are found as fragments that do not resemble the object from which they

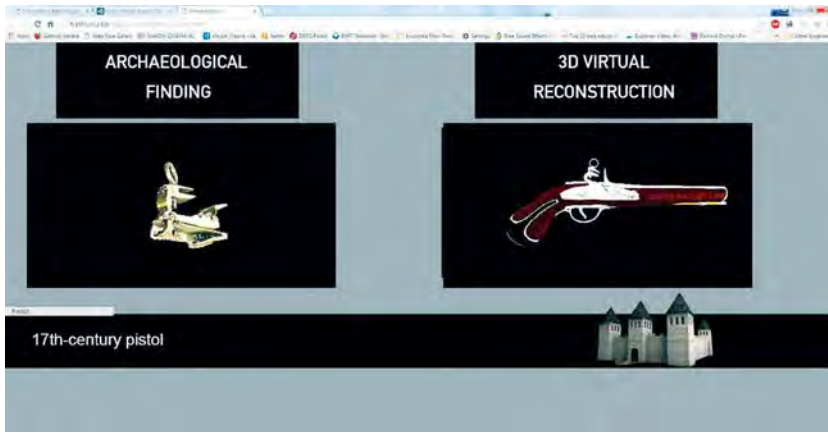

Figure 5.9. Display of an archaeological artefact and its virtual reconstruction. Screenshots of the White Bastion interactive application, 2016.

originate. 3D modelling is used to recreate the rest of the object. The users may click on the object's model, integrated in an IVE of the fortress (fig. 5.12) and open a screen, which shows both the digitized exhibit and its virtual reconstruction (fig. 5.9). Furthermore, the user can turn these objects around and interact with them in a way that is impossible in the physical museum.

We selected a group of twenty-two exhibits from all three historic periods of the fortress. The objects were digitized through photogrammetry. Thus, based on the acquired geometry, we reconstructed, in consultation with the expert archaeologist, the missing parts of each object to recreate its assumed original appearance.

Digital Stories Production

Digital stories were produced based on performance by a professional team from Bosnia Herzegovina Radio Television (BHRT). After the scenario and casting were finished, the director created a shooting guidebook as a reference for the whole TV crew. It included a detailed storyboard of all the stories with the text of narration, camera positions, and layouts of shots with visual effects. Graphics designers and visual artists created computer animations of different parts of the fortress and superimposed them onto the live footage of the fortress. They created computer animations of drawings of the characters whose appearance was not known. Computer animations of all six models of the fortress were designed and rendered according to the storyboard. The BHRT music production artists composed the original scores for the stories. They consist of different compositions for particular stories according to their topics. Shooting was performed in three locations

Figure 5.10. Location shooting of the story about the medieval period.

Figure 5.11. Location shooting of the story about the Ottoman period. Photos: Selma Rizvić, 2016.

in and around the Bastion using a HD TV camera, location lighting, and sound equipment (figs. 5.10 and 5.11).

The voice-over narration was recorded in the sound studio by the actor and a radio speaker read the technical information about the fortress. After the editing, sound and picture post-production, eleven stories were finished: the introduction and final story, stories about the medieval, Ottoman and Austro-Hungarian periods, the mosque, Hecimoglu Ali Pasha, the ammo room/post office, military music, and the reconstruction of the fortress in 1899.

Web Implementation

All the 3D models were exported from Cinema 4D to fbx format and imported into Unity 3D for illumination and scenes creation. We set up three cameras for each fortress model, but only the virtual camera placed inside the object provides the user with the possibility to browse around. The models of reconstructed archaeological findings were imported into the scenes and placed on a table inside the fortress. The users can click on them and open the reconstruction interface. As some of the interactive environments contain digital stories, we linked the story files to cut-out silhouettes of the soldier to be clicked for playing the stories. The user's view of the said objects and triggers is displayed in figure 5.12.

Figure 5.12. Reconstructed artefacts and the trigger for a digital story inside the White Bastion interactive virtual environment. Screenshot of the White Bastion interactive application, 2016.

Figure 5.13. Home page of the White Bastion project website with interactive animation, 2016.

With all the elements prepared, the scenes were exported from Unity 3D into the WebGL interactive format. The website of the project was created in WordPress. The home page contains an interactive animation of all the phases in the development of the Bastion which can be seen by moving the mouse cursor (fig. 5.13). From there the users can enter the page with the structure layout (fig. 5.1) and choose desired stories and/or IVEs (White Bastion/Bijela tabija website).

Critical Discussion and Evaluation of Research

We believe that the most relevant evaluation of virtual cultural heritage applications should come from the users. Our projects are intended for the general public and aim to revive and implant cultural heritage objects and sites into the collective memory of people. We aim therefore to satisfy all users. Our study of the users' experience evaluation was conducted according to the principles of qualitative user experience methodology.

Experiment Design

At this point we have performed only an initial study of the users' experience evaluation. We selected a group of twelve users: eight from Bosnia and Herzegovina and four non-Bosnians. Three of them were under twenty-five, seven between

twenty-six and fifty, and two over fifty years old. One reported poor computer literacy, six medium literacy, and five declared themselves expert computer users. Six of them sometimes play computer games, four of them do not, and two are regular gamers. Seven of the users visit museums occasionally and five are regular museum visitors. Their expertise differed. Some were computer scientists, some cultural heritage professionals, some language professors, and students of various disciplines. The Bosnian users were all from Sarajevo, so they could have had some prior knowledge about the object. Non-Bosnian users had no such knowledge.

The users were requested to visit the website of the project, explore its content and then fill out an online survey questionnaire. The questions in the user evaluation survey covered the following topics, which represented the objectives of our evaluation:

- User personal data (to identify to what target group the user belonged);

- Information perception (to find out how much users learned about the White Bastion from our application);
  - Q 1.1. When did you hear about White Bastion for the first time?
  - Q 1.2. From which historical periods originate remains at White Bastion's site?
  - Q 1.3. How many fortresses existed around the Old city of Vratnik?
  - Q 1.4. What was placed during the Ottoman period in the gunpowder magazine building?
- Interactive digital storytelling (to evaluate our concept);
  - Q 2.1. Which digital stories have you seen?
  - Q 2.2. On a scale from 1 to 10, how interesting and engaging did you find the stories?
  - Q 2.2.1. [if 9 or lower was chosen:] What would make it a "10"?
  - Q 2.3. On a scale from 1 to 10, how would you qualify the narrative?
  - Q 2.3.1. [if 9 or lower was chosen:] What would make it a "10"?
  - Q 2.4. On a scale from 1 to 10, how would you qualify the soldier character in the stories?
  - Q 2.4.1. [if 9 or lower was chosen:] What would make it a "10"?
  - Q 2.5. On a scale from 1 to 10, how would you qualify the music in the stories?
  - Q 2.6. On a scale from 1 to 10, how would you qualify the graphics (animated drawings) in the stories?
  - Q 2.7. On a scale from 1 to 10, how would you qualify computer animation in the stories?

Q 2.8. Is there anything you did NOT like in the stories?

Q 2.8.1. If yes, please describe what.

- IVEs (to establish the quality of presentation, navigation, and interaction; to discover if our triggers for inside stories and reconstructions of archaeological findings were intuitive enough for the users to find and explore this content);

  Q 3.3. What aspect(s) of 3D models did you like the best?

  Possible answers:

  geometry

  illumination

  Q 3.3.1. [add if not mentioned]

  Q 3.4. What do you think about the navigation through the models?

  Q 3.5. Have you seen digital stories inside some models?

  Q 3.6. Was it easy to find them?

  Q 3.7. Have you explored models of digitized and reconstructed archaeological findings?

  Q 3.8. Was it easy to find them?

  Q 3.9. On a scale from 1 to 10, how would you qualify the presentation of digitized and reconstructed archaeological findings?

  Q 3.9.1. [if 9 or lower was chosen:] What would make it a "10"?

- Overall user satisfaction (to identify where in development of the application we succeeded and where we have failed);

  Q 4.1. On a scale from 1 to 10, how would you qualify the White Bastion application?

  Q 4.1.1. [if 9 or lower was chosen:] What would make it a "10"?

  Q 4.2. Did you feel immersion in the past of White Bastion?

  Q 4.3. What do you think about the combination of digital stories and interactive 3D models?

  Q 4.4. Should all stories have been inside models?

  Q 4.5. Would you prefer this kind of presentation over a documentary movie?

  Q 4.5.1. If yes, please describe why

  Q 4.6. What did you like the best in the White Bastion application?

  Q 4.7. What did you not like, or think could be corrected?

Results

The qualitative user experience evaluation methodology we used in our user study consists of the following steps. Firstly, the hypotheses which needed to be proved by the research are defined. Then the users are interviewed or asked to fill out questionnaires and provide relevant information. Their answers are coded and analysed in order to prove the previously defined hypotheses. In this user study we established the following hypotheses:

H1: Users learn about cultural heritage objects from virtual cultural heritage presentations.

H2: Through interactive virtual cultural heritage presentations users feel immersed in the past.

H3: Users prefer interactive cultural heritage presentations over documentary films.

In the information perception section of the user study we asked some questions from White Bastion's history about topics mentioned in the stories. Out of three questions we asked, two of them were answered correctly in almost 100 per cent in the case of Bosnian users (only one answer was wrong), while the third question was answered incorrectly by 62.5 per cent of users. The reason for this could have been the fact that they did not watch the corresponding story, which was available within the virtual environment. The answers to one question from this section by the non-Bosnian users were 100 per cent correct and only one of them did not answer correctly the remaining two questions. From these results we can conclude that our hypothesis H1 has been proven.

At the beginning of the evaluation of our interactive digital storytelling concept we investigated how many digital stories users have watched. We divided the stories into two groups, according to their position in the interactive project structure (fig. 5.1):

S1: stories with direct access (intro, three stories about time periods in the history of the fortress, and the end story);

S2: stories placed inside IVEs (the mosque, Hecimoglu Ali Pasha, the ammo room/post office, military music, and reconstruction of the fortress in 1899).

All the Bosnian users watched the introductory story and all but one watched stories about all three periods in the fortress's history. The stories from the S2 group were seen by approximately half of the users. Four out of eight users watched the end story. Three out of eight users reported that it was not easy to find stories in

IVEs. The non-Bosnian users watched three stories about time periods; two out of four watched the introductory story and none of them watched stories from the S2 group. We believe that the reason for not watching S2 stories was that they could not find them, meaning that our soldier-trigger was not intuitive enough. Only three out of twelve users think that all stories should have been placed inside IVEs. Regardless, the users marked the stories very highly (ten out of twelve users gave them 10 on a scale from 1 to 10). All users found them interesting and engaging. The soldier character was the most appreciated element in the stories.

An evaluation of IVEs shows that all Bosnian and three out of four non-Bosnian users explored them. The majority of users appreciated their appearance. Six out of twelve had no problems with navigation, while five reported some problems. One user could not open them at all. In general, the IVEs of the Bastion models are slow to load (about five minutes when using a good Internet connection). We need to address this problem through the optimization of their geometry. Another problem is that they do not work well on mobile platforms and so we are looking for the best solution to this. Regarding the archaeological findings and their reconstructions, seven out of twelve users succeeded in finding and exploring them in the IVEs, while five users have not. Those who found them expressed their appreciation with the highest mark.

Eleven out of twelve users reported that they felt immersed in the past, which confirms our hypothesis H2. One of the most important questions for us in the user evaluation was whether the interactive virtual cultural heritage presentation is preferred over a sequential presentation in the form of a documentary. Ten out of twelve users answered this question positively, which confirms our hypothesis H3. A number of users commented on some advantages and drawbacks of this approach. Most of them reported feeling more engaged and paying more attention in the interactive presentations. They appreciated the possibility of exploring the IVEs which they could not do in a film. They liked the combination of digital stories and models because "models are described by stories and can display the information from stories." Two users noted that in this kind of presentation information is scattered and they cannot be sure they did not miss something. They preferred to be offered a tailored story than to create it themselves through interaction.

Future Research and Conclusion

In this chapter we have presented a new concept of interactive virtual cultural heritage presentation, consisting of a combination of digital storytelling and IVEs. We can conclude that this form of presentation is more attractive and engaging for the majority of users who feel immersed in the past and gain more information about the presented site and its history. Digital storytelling needs to be carefully

designed and the introduction of one or more characters is highly appreciated. The projects need to be implemented by multidisciplinary teams of professionals, with particular emphasis on graphics design and visual arts, as the visitors find these elements most attractive.

A lot of work still remains to be done in devising a concept appreciated by *all* target user groups. From the results of the evaluation survey we could see there are still some users who prefer traditional forms of communication. Some problems with navigation in IVEs need to be solved to attract more users to interactive presentations. We still need to research what the ideal duration of individual story units should be and how they should be interconnected between each other, and with IVEs.

However, we believe that the time is ripe for these forms of communication. We need to work to help users to perceive cultural heritage in the same way they perceive millions of online bits of information, bombarding them every day. Digital technologies and storytelling are thus powerful tools to help implement the perennial idea of travelling to the past.

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