



Giulia Pettoello

Architect and researcher at the DSDRA at the Sapienza University of Rome. She graduated with honours at the Sapienza University of Rome in 2012 and studied at the Polytechnic University of Valencia in Spain through the ERASMUS Program. In 2012 she registered with the Association of Architects in Rome. In 2014 she completed a three months internship at the Duke University in the USA.

Multisensory museum. A proposal for personalized virtual knowledge of the Vulci Archaeological Park

Museo multisensoriale. Proposta per una conoscenza virtuale persona-

Everyone interacts daily with external reality, and such behavior occurs naturally and spontaneously. The mechanism established is always multisensory and there are, in fact, multiple senses involved. Physical experimentation is natural in children's behavior and is so strong that it also persists into adulthood. If this occurs in everyday life, why should it not also be so when experiencing the cultural heritage? Starting with this idea, this paper describes a proposal for a personalized multi-sensory and immersive itinerary for the Vulci Archaeological Park.

Ogni individuo quotidianamente si relaziona con la realtà esterna e tale comportamento avviene in maniera naturale e spontanea. Il meccanismo che si instaura è sempre multisensoriale ed infatti sono molteplici i sensi ad essere coinvolti. La sperimentazione fisica è naturale nel comportamento del bambino ed è talmente radicata che perdura anche in età adulta. Se ciò si verifica nella vita di tutti i giorni, perché anche nella fruizione del bene culturale non dovrebbe essere così? È in quest'ottica che il paper descrive una proposta per un percorso di visita personalizzato, multisensoriale ed immersivo, per il Parco archeologico di Vulci nel Lazio.

key words: Cultural heritage; senses; experimental knowledge; digital narration.

parole chiave: Cultural Heritage; sensorialità; conoscenza sperimentale; narrazione digitale.

1. MAIN GOALS

The paper describes a proposal to create a personalized, multi-sensory and immersive guided tour for the Vulci Archaeological Park[1]. The route is ‘integrated’ (Fig. 1) [2], that is, not just real or virtual, but derived from both approaches because “making virtual information tangible, even in the virtual environment, makes the information more accessible and enhances knowledge transfer” (Milekic, 2010, p. 373). Just as a person uses different senses—sight, touch, hearing—in daily experience, likewise the visitor, taking advantage of the integrated itinerary created, can interact directly and deeply with cultural heritage because “whilst we only remember ten percent of what we read, we remember ninety percent of what we do” (Hazan, 2010, p. 143).

The idea is therefore to communicate the cultural heritage through digital means with the aim of multiplying the attractive value of the immense national cultural heritage. Specifically, in the research presented in the paper, different techniques are examined and applied in order to involve the user, enhancing the role of the cultural heritage and museums in particular, with a multisensory museum that can be investigated depending on the user’s interests (Fig. 2). A secondary theme is the investigation of the interaction between humans and technology where “new interactive media play a decisive role, generating new languages that multiply the work of art’s narrative levels creating new contexts of perception” [3]. Such considerations were made by proposing a flexible guided tour, designed according to a communication model built on the use of immersive and interactive digital applications aimed at spreading knowledge. The main goal was therefore to integrate different technologies and languages, also creating a technological structure that could be adapted according to different needs and cultural messages, in order to correspond to as many users as possible (Fig. 3).

2. FOR A SENSORY APPROACH. STATE OF ART

The starting point in defining the cultural itinerary proposed was a critical analysis of the digital communication of the cultural heritage. Both theoretical aspects

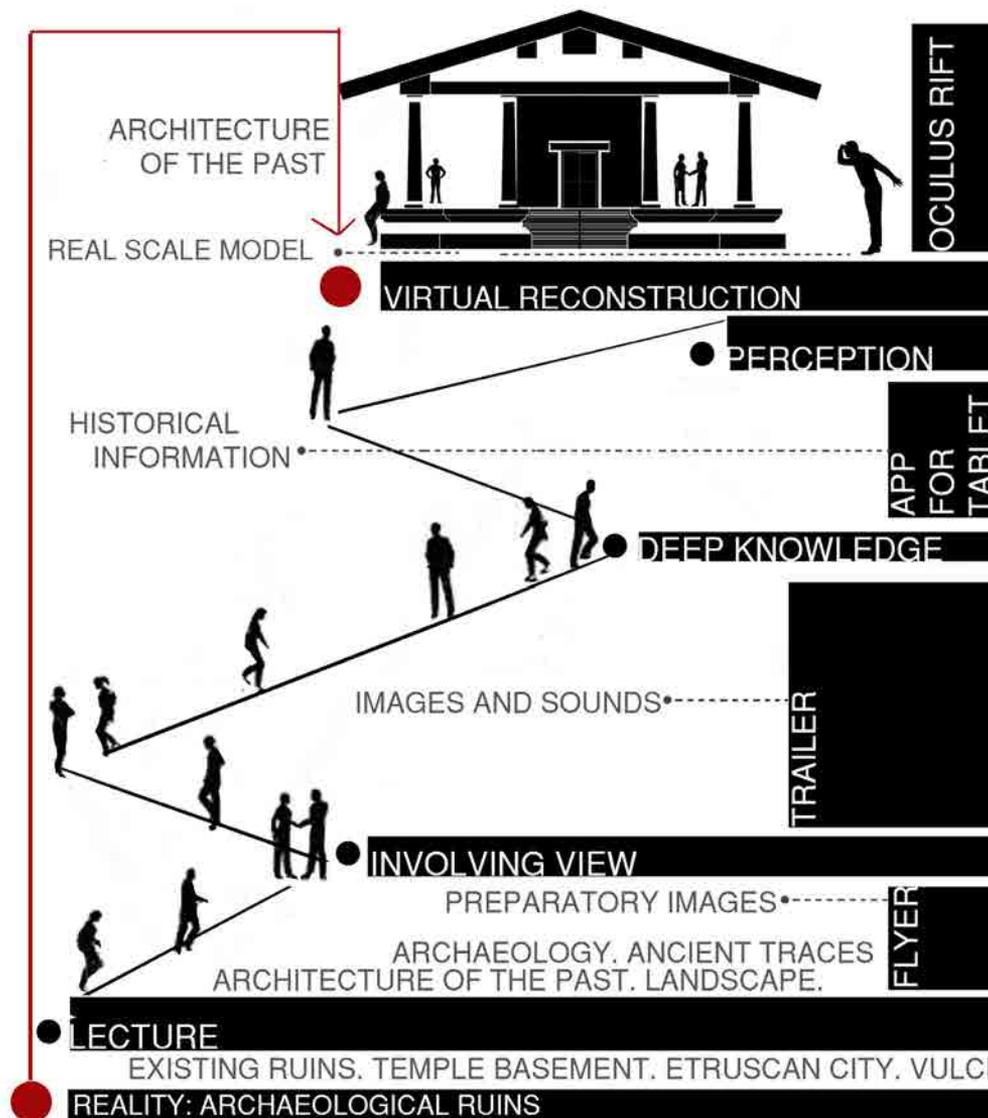


Fig. 1. The design of the integrated tour route.

(scientific publications) and practical aspects (case studies) were carefully considered to define, as far as possible, a coherent framework useful for the design process. Some of the case studies examined are synthesized below. They were chosen not only with reference to the technological issues but above all to the *concept* proposed. In fact, the examples chosen are characterized by a strong emotional and psychological link between the cultural heritage and visitors. This link represents for the visitor a chance to become an active player who 'experiences' the cultural asset through various channels.

BACKGROUND

In the following selected case studies, different senses are involved and the communication established between the user and the cultural heritage is bidirectional (Allen & Lupo, 2012). This common thread was also the element driving the museum itinerary as designed.

Case Study 1: Museo della mente (Studio Azzurro, Italy

2000). "The impact is strong, but at the same time, the museum avoids the spectacle of the mental disease. The visit is an intimate path, cognitive and experiential." [4]. ICT: Within sophisticated technology the museum offers archival documents and testimonies of life about the hospital history, helping the understanding of a complex subject. Sensitive and interactive tables, projections and sounds designed by Studio Azzurro coexist.

Case Study 2: You are not Here (New York USA and Tel Aviv 2006). This installation invites participants to become meta-tourists, simultaneously visiting multiple cities simply by using a downloadable paper map and a mobile phone. This project proposes a fascinating use of technology to modify the relation between people and places, creating a sense of dislocation and displacement. ICT: The entire project relies therefore on audio descriptions, accessible through a mobile phone feature and a paper map, which must be printed beforehand.

Case Study 3: Fabrica - Les yeux ouvertes (Milan-

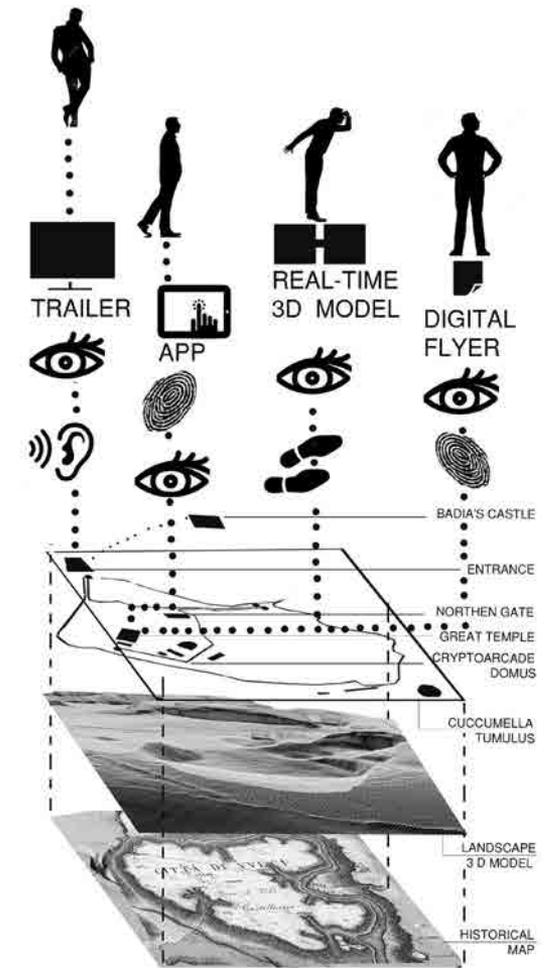
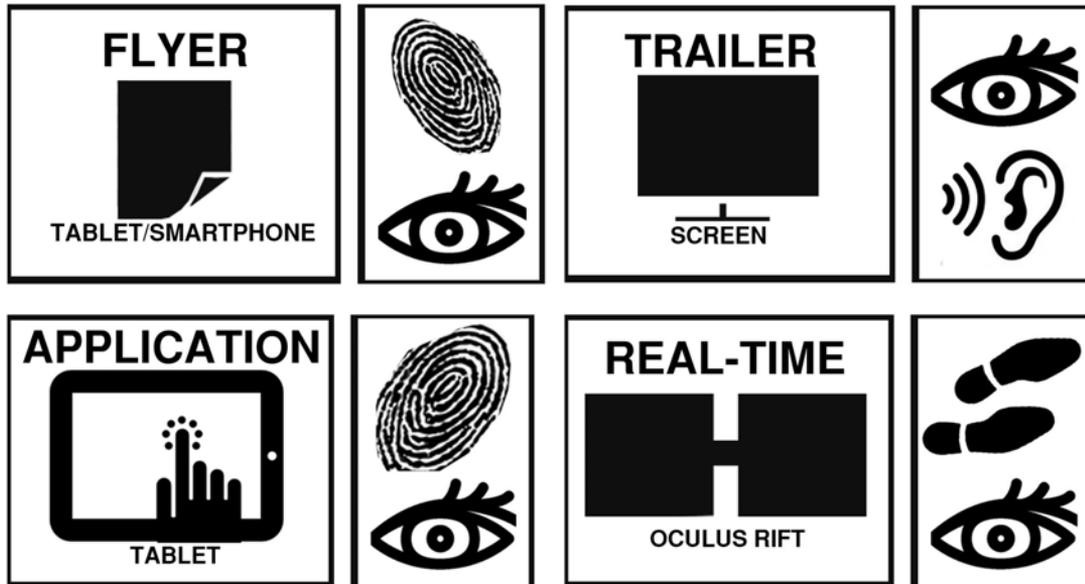


Fig. 2. Multisensory Museum. Design of the 4 levels.

Fig. 3. The cultural itinerary: Reading filters applied to the communication of the archaeological site.



Shanghai 2006). It is a temporary and travelling exhibition about the experimental and interdisciplinary activity of Fabbrica, the communication research center of the Benetton Group based in Treviso. ICT: Images, videos, sounds as well as text are all employed in the exhibition. For example in one of the four sections of the exhibit people are asked to climb stairs to create a personal melody.

Case Study 4: Sensitive City (Studio Azzurro, Shanghai 2010). "Sensitive City appears to the visitor as a path in constant transformation, able to preserve and transmit the traces of its storytellers"[5]. The 'other spaces' are recreated with projections and sounds. ICT: Life-size figures projected on a vertical surface, the storytellers, pass by the visitors who can stop them and invite them to speak by raising their hand.

Case Study 5: Terme di Diocleziano (F. Antinucci, Italy 2015). "The idea is about creating a dialogue between one or more actors and a statue, a bust of one of the characters mentioned in the epigraph"[6]. ICT: Graphics and animations illustrate the dialogue by the use of images.

3. DESIGN OF THE MULTI-SENSORY GUIDED TOUR

ESSENTIAL DESIGN ASPECTS

From case studies described above briefly and from additional cases that for brevity have only been mentioned in the bibliography, some particularly significant and useful aspects have been collected. These elements were useful in establishing the requirements for the design of the multi-sensory tour created for the Vulci Archaeological Park located in Lazio region.

- *The user*. The key issue is to rethink the role of the user, who is no longer found offstage, but is turned into an active subject so that the museum will become "an open, flexible institution, attentive to the needs of its audiences, rather than the remote elite institution" (Witcomb, 2010, p. 37).

- *Experiential element*. Whether considering exhibits made with traditional or digital techniques, what is essential is the control of the communicational content and, in the case of the cultural heritage, this means historical information quality. But in communicating a

cultural object proposed as an 'experience', and therefore effective knowledge, it is necessary to enrich the 'tangible' information with 'intangible' content. This is what is known as the 'experiential element', which, to be created, needs to integrate the information regarding the cultural heritage itself with the characteristics and qualities of the environment closely related to it. "Saturating a virtual environment with detail does not necessarily create a strong sense of place. For example, fog and London appear as almost inseparable in literature, paintings, and most people's memories of the city. This suggests that we often remember a place through its atmosphere rather than through accurate recall of details" (Champion, 2010, p. 336).

- *First-person experience*. In communicating a cultural object, it is also crucially important to identify forms of enjoyment that make the content 'tangible', even if it is virtual. This means designing installations that allow for concrete interaction, deriving them from the ways in which communication and knowledge occur in everyday life, that is, acting daily through the use of the senses. The example of building a puzzle, quoted below, illustrates the possibility of first-person interaction in relation to knowledge acquisition. "A possible approach putting the puzzle together would simply be to look at each piece and figure out mentally where its place would be. However, both children and adults often use the strategy of 'trying out' the fit of various pieces, and rotating the pieces themselves rather than trying to perform the same operation mentally. These actions, have the purpose of making the task easier by reducing the cognitive effort necessary to achieve the goal" (Milekic, 2010, p. 370).

- *Multiple interaction*. Interaction with the information that is as concrete and tangible as possible is therefore of great importance. It is thus necessary to reflect on how this interaction can be realized and what the most appropriate technological tools are to achieve the goal. In this sense, the reflection could be translated in terms of a comparison between traditional and current interfaces, for example, as has been observed "one of the problems with the traditional 'point-and-click' interface was the increased separation of the hand and the eye. In performing operations on digital data, the eye was given the mayor role of identifying, focusing,

monitoring and interpreting, while the hand was reduced to performing simple repetitive gestures" (Milekic, 2010, p.374).

- *The tangible*. As described below, in the cultural itinerary proposed, the visitor is involved and stimulates the senses through several different methods, interfaces, and technologies: the sound of a trailer, the real-time exploration of a virtual space, the sense of touch in the application. Depending on its nature, scope, and complexity, each family of information[7] corresponds to the involvement of a specific sense, thereby making the different information become tangible. Introducing a tangible aspect into virtual communication allows the experiential dimension to be introduced. It is therefore possible "communicating complex concepts without the need for explicit formalization, reducing cognitive load by using intuitive body knowledge." (Cameron & Kenderdine, 2010, p.336).

THE DOCUMENTATION

The Vulci archaeological site contains many ruins related to different eras. An Etruscan city founded around the eleventh century BC, then a Roman town in the late Republican era, it grew continuously until Late Antiquity.

As it was investigated from the archaeological point of view only beginning in the 1800s, "compared to other large Etrurian sites such as Cerveteri or Veio, the [knowledge] of Vulci is undoubtedly much more scarce because of events related to the excavation history" (Moretti Sgubini, 2010, p.179). In the city, Roman ruins exist almost exclusively, for example, some ruins of the Forum, including the base of the "Great Temple, located in north-western sector of the urban area, along a road axis that can be traced from the decumanus of the Roman period, which came to light in 1960" (Moretti Sgubini, 2010, p.179). The excavations in the Great Temple area returned "a considerable amount of architectural terra cotta, which, traced in deposits, allowed for the recognition of the different building phases of the complex, in use from the late Archaic to the Roman era" (Moretti Sgubini, 2010, p. 179). Throughout the present work, the choice was made to develop a specific phase that characterized the transformation of the place examined: the late Archaic period.

The proposed archaeological site visit focused exclusively on the state of the places related to the late Archaic period, focusing in particular on the reconstruction of the Great Temple within the landscape. Due to many fortunate circumstances, the temple is preserved today similar to its nineteenth-century state. To define a scientific reconstructive hypothesis, it was necessary to compare data obtained from literature sources (the main ones in the bibliography) with those derived from the survey. In particular, to acquire the metric-geometric data, the technique of photomodeling was used[8]; this formed the basis for the three-dimensional reconstruction of the temple basement.

Methodology and structure of the designed itinerary

To design a visit capable of making the various archaeological features accessible, a 'stratified' functional model was created. The model interactively communicates the different characteristics, from natural characteristics to archaeological and architectural ones. Once the 3D model of the Vulci landscape was reconstructed, four different installations were designed, each involving a specific sensory level: the promo-trailer - involving vision and hearing, the application for smartphones or tablets - involving vision and touch, the model explorable in real-time - involving vision and the possibility of exploring the virtual space, and finally the digital flyer - involving vision and through which a tangible trace of the visit is left with the visitor (Fig. 4). The 'layered' model thus allowed the main goal of the research to be reached, i.e., designing a customized visit and offering various suggestions through which visitors can move freely and choose the level of investigation.

Through the close relationship between the digital reconstruction of the cultural heritage—the *digital heritage*—and the real cultural asset—the archaeological site—thereby connecting 'intangible' and 'tangible', the communication of knowledge about the cultural heritage is achieved. Therefore, after travelling through the various exploratory focuses, visitor can create their own experience of the archaeological site.

In order to establish the themes and outline the overall objectives of the project, it was necessary to define a 'macro structure' which led to the development of four

'micro-structures' useful in designing the overall tour route.

The 'macro-structure' was organized into five closely connected phases: the choice of the case study, analysis of documentary sources, survey and data systematization, 3D modelling, and project development activities.

Each 'micro-structure' was marked according to four interrelated levels: content analysis, establishing the communicative language, the choice of technology, and realization of the prototype.

Installations design

A common element among the various installations is the introduction of the experiential element within the cultural route.

The four filters designed and placed between the cultural object and the user are translated into concrete sensations. Rather than being descriptions or captions, communication in the visit designed and prototyped is direct and immediate. The experimental approach proposed regarding the Vulci Archaeological Park focuses in particular on the Great Temple, of which today only a few remains of the original basement still exist. To understand the archaeological remains, several overlapping levels of information are proposed. In fact, once the itinerary is completed, the perception of the former object, even if virtual, is accomplished.

-The video trailer prototype[9] briefly narrates (it has a duration of only 50 seconds) a story through the interaction of images, sounds, and words (Figs. 5–8). In the trailer, everything is focused, specific, and targeted in order to create a story that empathically captures the visitor's interest. The video acts as a preview designed to discover the site, but also to disseminate a wider spectrum of knowledge about the ancient object. In fact, because it is very concise, it is also enjoyable via Web.

-The application prototype[10] allows the user to travel through time, moving freely between past and present thanks to a responsive slider (Fig. 9). With the aim of not having a user interface perceived as a barrier, the slider is not visible on the monitor. A touch-activated switch was therefore chosen: by sliding a finger on the screen, the archaeological remains are transformed,

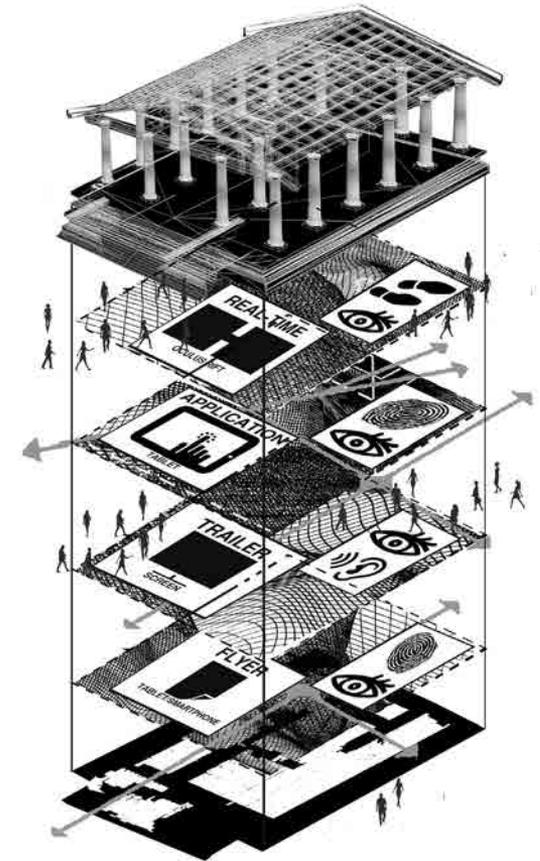


Fig. 4. From ruins to the Great Temple virtual reconstruction.

responsively and in real time, and the Great Temple in the Late Archaic era is visualized step by step. For better understanding, the user is offered not only the reconstruction of the external 'skin' of the building but also a detailed view of the hypothesis of the original inner structure. In this way, the communication realized is a dynamic reconstruction of the past, that is, the possibility for the user not only to view the reconstruction but to proactively take part thanks to the possibility of investigating the different reconstructive phases.

-The real-time model prototype[11] (Fig. 10) instead allows the visitor to move freely in exploring the spatial reconstruction of the cultural landscape using the default setting—*fixed flow*—or a more instinctive use—*random flow*. To achieve a greater perceptive experience and thus lead the visitor to feel a part of the virtual space, the reconstruction of natural elements was introduced. Elements such as vegetation and water that react to the wind, for example, contribute to reconstructing the atmosphere.

In this way, the virtual tour is enriched to increasingly become a complete experience, where the use of three-dimensional space guides the visitor in a process to discover a new place that is revealed, as in reality, step by step.

Finally, the flyer prototype[12], which replaces a traditional brochure, aims to leave visitors with a tangible memory of the recent experience, with the ability to share it online (Fig. 11).

4. CONCLUSIONS

The main innovative elements of the experimentation described above reside primarily in the structure of the communication project, where, in contrast to usual installations, multi-level informational content is offered through the use of various technologies and devices. Starting with this approach, a customized, multi-sensory, and immersive tour route was designed to make visitors as involved as possible, transforming their role from *viewer* to *user*.

The communication project was therefore based on a basic conviction, i.e., it is the action that stimulates participation, which in turn stimulates involvement (Cameron & Kenderdine, 2010, p. 107). The proposal is

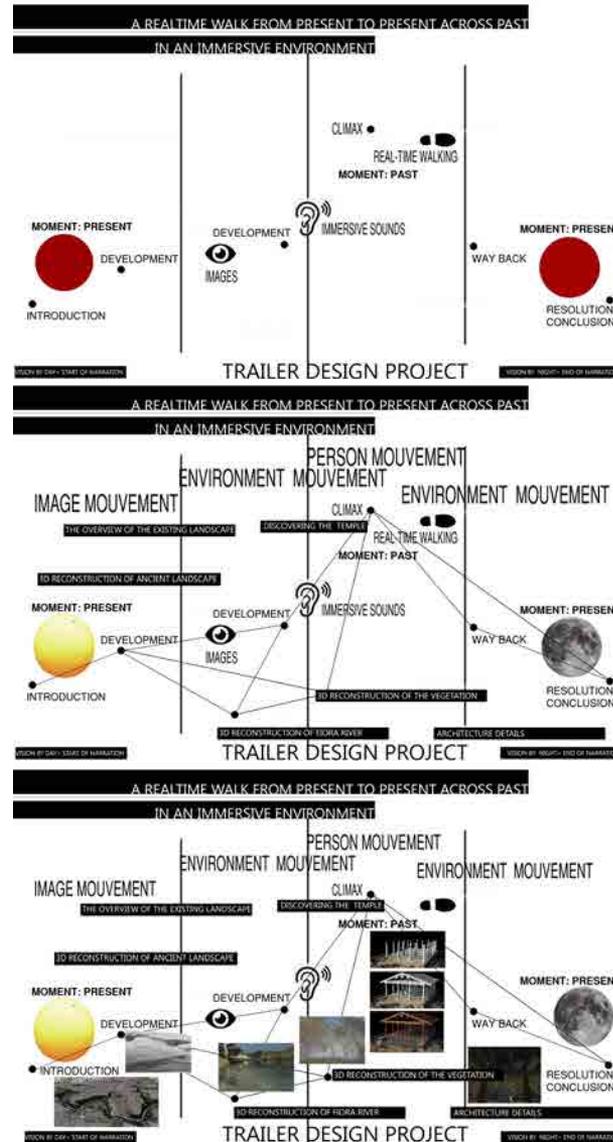


Fig. 5. Trailer design project: scheme n. 1
Fig. 6. Trailer design project: scheme n. 2
Fig. 7. Trailer design project: scheme n. 3



Fig. 8. Synthetic scheme: the narrative video trailer.

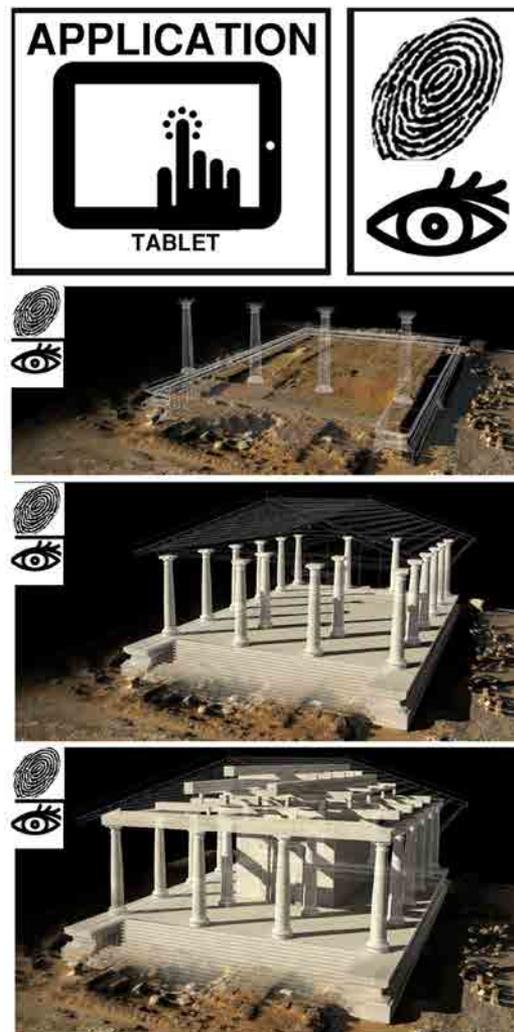


Fig. 9. Synthetic scheme: the application for tablet.

therefore to experience "active knowledge", where the visitor has the chance to become the main character moving through the different levels offered by the integrated path. The promo-trailer, the model explorable in real-time, the application, and the online flyer, however, are only some of the possible outputs.

As a conclusion, a comparison between the features of the four installations is considered useful. The promo-trailer is functional in the phase to approach the cultural asset, which is presented in its entirety, from the natural to the archaeological and architectural characteristics.

Through fluid, dynamic narration of images and sounds, visitors have the opportunity to immerse themselves in the original environment of the cultural good. With the smartphone application, the user plays a more active role compared to viewing the trailer. During this step, viewers can pause on specific issues they find interesting, for example, analyzing in detail some information such as the simulation of the construction of the wooden structure (Fig. 12). By exploring the 3D model in real time, visitors are offered greater involvement: the previously acquired information allows users to proceed autonomously, diving into the reconstructed landscape thanks to the 3D visor (Fig. 13).

Finally, both on site and online, the digital flyer allows visitors to investigate the different sources, to 'touch with their hands' the original historical drawings, that is, to complete their active knowledge by experiencing a 'complex virtual image' of the place and the atmosphere that create the cultural asset.

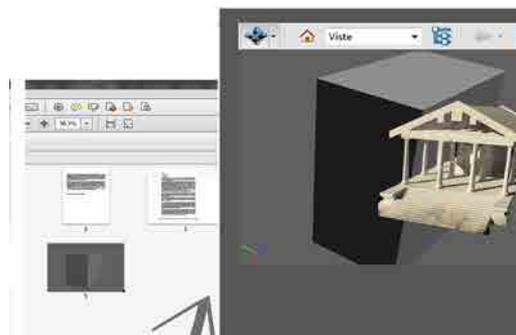
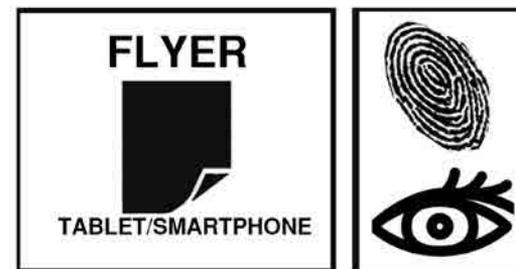
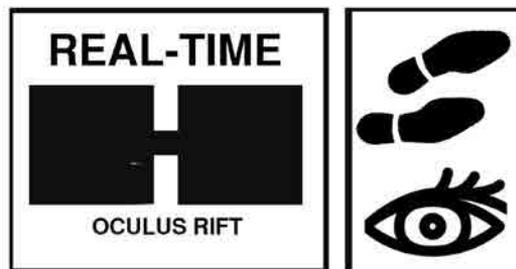


Fig. 10. Synthetic scheme: the real-time 3D model.

Fig. 11. Synthetic scheme: flyer on-line.

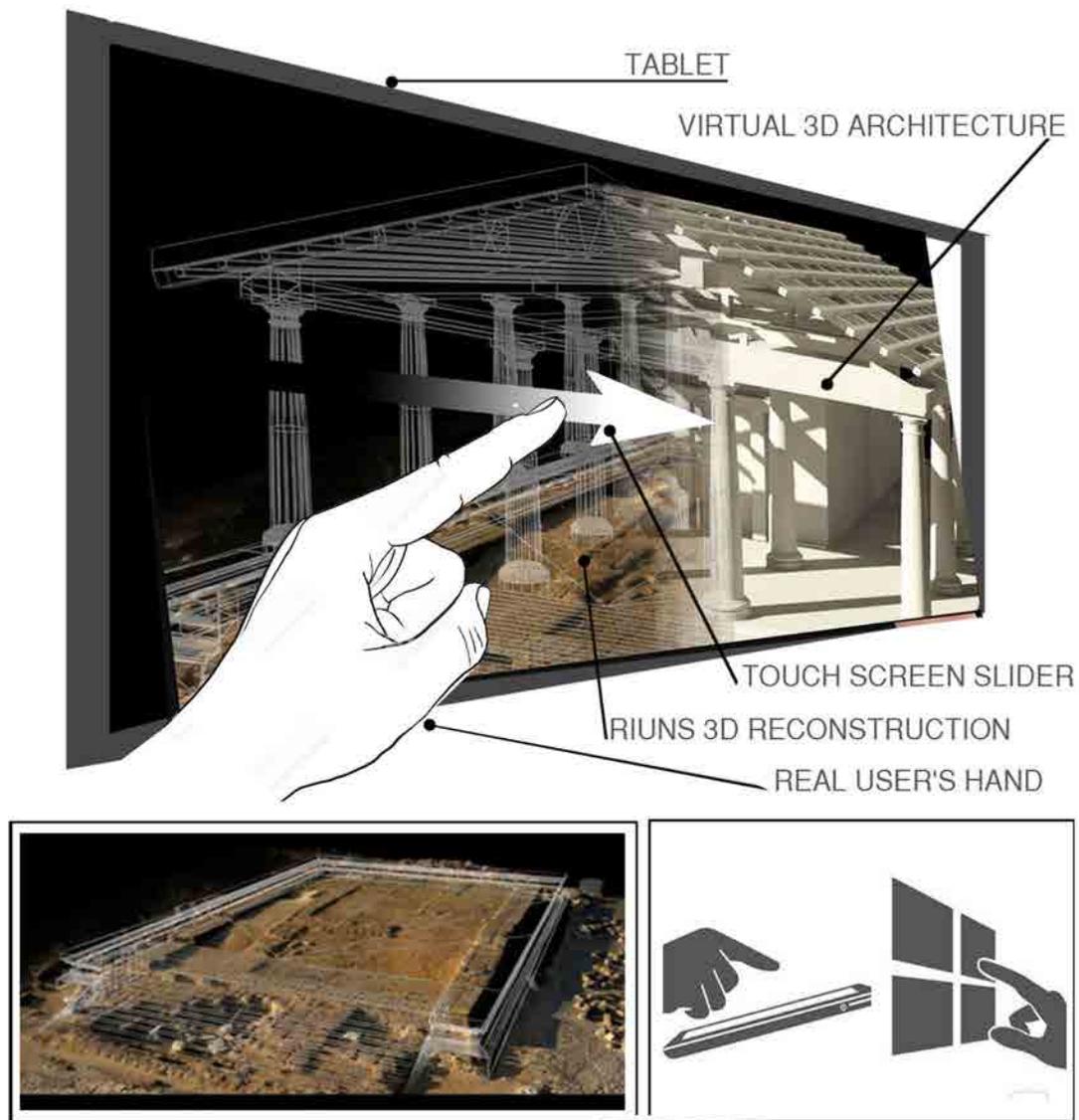


Fig. 12. Example of application fruition.

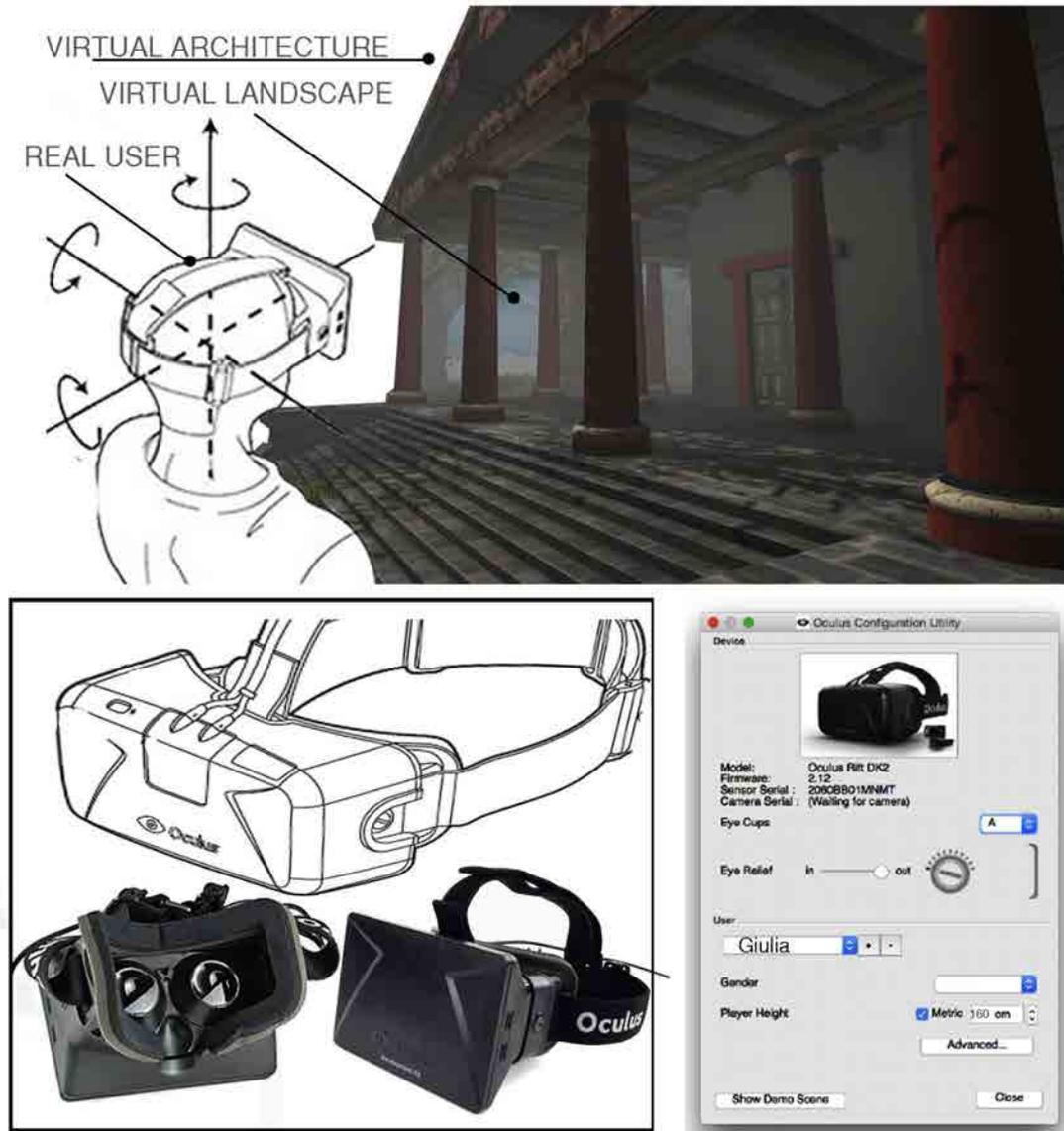


Fig. 13. Example of real-time 3D model fruition.

NOTES

[1] The experience presented derives from and amplifies what was addressed in one of the themes of the Doctoral thesis. Title: *Mutable Museum: digital for cultural heritage valorization*. A.A. 2015-2016. Tutors: prof. Mario Docci, prof. Carlo Bianchini, prof. Emanuela Chiavoni. Acknowledgments: prof. Maurizio Forte, Nevio Danelon - Duke University.

[2] Unless otherwise stated, the images were created by the author.

[3] <http://www.urbanexperience.it/eventi/il-museo-sensibile-tramemoria-del-territorio-e-innovazione/>. Last reference: 10 October 2016.

[4] <http://www.museodellamente.it/it/>. Last reference: 27 November 2016.

[5] <http://www.digitalperformance.it/?p=1819>. Last reference: 27 November 16

[6] <http://www.stefanoscialotti.it/art/terme-di-diocleziano.html>. Last reference: 27 November 16

[7] The main families of information are historical archive sources, the transformation of the temple in the various eras, the structural analysis of the building, and the study of the decorations.

[8] Agisoft Photoscan Professional was used for the photomodelling, while the photographs were taken with a digital Canon Esos 6 D 20 megapixel full-frame camera.

[9] Adobe Premiere was used to create the video trailer prototype.

[10] Programming languages including Java Script were necessary to create the application prototype.

Rhinoceros and 3D Studio Max were used to create the 3D model.

[11] As mentioned above, to create the model prototype, Agisoft Photoscan Professional was used to develop the point-cloud mesh derived using the same software. Rhinoceros was used to interpret the mesh and develop the mathematical NURBS models of the Great Temple reconstruction. 3D Studio Max was used for the texturing operations. Blender software was used to optimize the model, i.e., a light model useful for real-time navigation. Unity 3D was used to create the navigable virtual space.

[12] Adobe Acrobat DC was used to create the flyer prototype.

BIBLIOGRAPHY

Albisinni, P., & Maestro, R. (2002). *Il disegno dell'architettura tra tradizione e innovazione*, Collana Strumenti del Dottorato di Ricerca in Rilievo e Rappresentazione dell'Architettura e dell'Ambiente. Roma, Italia: Gangemi Editore.

Allen, J., & Lupo, E. (2012). *Representing Museum Technologies*. Milano, Italia: Mela Books.

Antinucci, F. (2007). *Musei virtuali. Come non fare innovazione tecnologica*. Roma, Italia: Laterza.

Antinucci, F. (2009). *L'algoritmo al potere, Vita quotidiana ai tempi di Google*, Roma, Italia: Laterza.

Bradburne, J. (2005). *Heritage Interpretation*. London, Gran Bretagna: English Heritage/Routledge.

Cameron, F. & Kenderdne, S. (2010). *Teorizing Digital Cultural Heritage, a critical discourse*. London, Gran Bretagna: The MIT Press.

Champion, E. (2010). *Dialing up the past*. In Cameron, F. & Kenderdine, S. *Teorizing Digital cultural Heritage, a critical discourse* (pp. 333-347). London, Gran Bretagna: The MIT Press.

De Luca, L. (2011). *La Fotomodellazione architettonica*. Palermo, Italia: Dario Flaccovio Editore.

Handler Miller, C. (2008). *Digital Storytelling, A Creator's Guide to Interactive Entertainment*. Amsterdam, Paesi Bassi: Elsevier. Waltham, Massachusetts, USA: Focal Press.

Hazan, S. (2010). *A crisis of Authority: New Lamps for Old*. In Cameron, F. & Kenderdine, S. *Teorizing Digital Cultural Heritage, a critical discourse* (pp. 133-147). London,

Gran Bretagna: The MIT Press.

Ippoliti, E. (2013). *Shedding light on the cultural heritage. The Ascoli Piceno experience*. Roma, Italia: Aracne editore.

Kelly, L. & Russo, A. (1998). *A Digital Collections: Museums and the Information Age*. Oxford, Gran Bretagna: Butterworth-Heinemann.

Levy, P. (1997). *Il virtuale*. Milano, Italia: Cortina Raffaello Editori.

Migliari, R. (1991). *Il disegno degli ordini e il rilievo dell'architettura classica: Cinque Pezzi Facili*. In *Disegnare, idee, immagini*, 2, pp. 49-66.

Milekic, S. (2010). *Tangible virtualities*. In Cameron, F. & Kenderdine, S. *Teorizing Digital cultural Heritage, a critical discourse* (pp. 369-388). London, Gran Bretagna: The MIT Press.

Moretti Sgubini, A. M. (1993). *Vulci e il suo territorio*. Roma, Italia: Quasar.

Moretti Sgubini, A. M. (2010). *Vulci, Veio, Cerveteri Tarquinia, Città d'Etruria a confronto*. Roma, Italia: l'Erma di Bretschneider.

Serrel, B. (1996). *Exhibit labels. An interpretative approach*. California, USA: Alta Mira press.

Stopponi, S. (1985). *Case e Palazzi d'Etruria*. Milano, Italia: Electa Editrice.

Witcomb, A. (1995). *Changing media, changing messages. In Museum, Media, Message*. London, Gran Bretagna: Routledge.

Witcomb, A. (2010). *The materiality of virtual technologies*. In Cameron, F. & Kenderdine, S. *Teorizing Digital Cultural Heritage, a critical di-*

course (pp. 35-48). London, Gran Bretagna: The MIT Press.

Zeki, S. (2007). *La visione dell'interno*. Torino, Italia: Universale Boringhieri.