

# The Use of Holographic Showcases Inside the Museum's Context. Towards an Advanced Museology Creating a Dramaturgy Around the Exhibited Objects

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A new challenge, in the museological domain, is the use of the holographic effect of Pepper's Ghost to develop a novel frontier in storytelling inside museums, integrating in the same space real and virtual contents, and creating a virtual dramaturgy around the real object. This integration has a communicative potential never seen before inside museums, because it works in perfect harmony with the museum visit and the real artifact is kept in the middle of a lively experience of mixed reality. Narration is a central issue, because it involves not only creative and technological but also "ethical" and cultural choices, inherent the scientific correctness and plausibility of contents, while using agile and multiform tools like the digital ones. Case studies will be discussed, presented and tested on the public in different European museums, in the framework of the EU project CEMEC. In fact within this project we have conceived the "box of stories" a holographic showcase where (a) integration of real and digital contents, (b) structure, (c) materials, (d) interior setup, (e) illumination, (f) narrative approach and dramatization, (g) scalability are designed as a whole. Since the holographic effect is an illusion of reality, there are specific rules and constraints regarding technical set up, perception and editing of contents that must be respected and that will be discussed.

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## Keywords:

Holographic Showcase, Emotional Storytelling, Mixed Reality, User Experience.

## CHNT Reference:

Eva Pietroni et al. 2018. The Use of Holographic Showcases Inside the Museum's Context. Towards an Advanced Museology Creating a Dramaturgy Around the Exhibited Objects.

## STORYTELLING INSIDE MUSEUMS, WORDS AND IMAGES WORKING TOGETHER

Learning does not arise simply from our reasoning, but also through curiosity, engagement, interest and attention; in one word, through motivation. In this process emotions play a crucial role, stimulating a feeling of self-identification, appropriation and elaboration of the meaning [Pietroni et al. 2018]. For the same reason narration is much more powerful than pure description, because this latter is not able to induce motivation, unless the beneficiary is already familiar with that specific content. When using narration, evocation or even dramatization, objects become the occasional points where history "coagulates", creating an expectation in the visitors. The tale is developed by including different perspectives, different rhythms, and it draws up a specific space-time dimension [Genette 1972]. Everything contributes to create an expressive unity: oral performance/recitation, layout, visual mood, soundscape, camera movements, lighting, and rhythms.

Despite narration is an atavic expressive form of human beings, and one of the most effective vehicles of involvement, today it is one of the weakest aspects in the cultural heritage communication, both in real and in virtual museums [Pietroni and Adami 2014]. In the field of Cultural Heritage, visualization usually aims at analyzing the object, providing a perfect perception of its shape, texture and structure, and it is often accompanied by descriptive explanations. Rarely visualization is conceived as visual storytelling, the union between word and image results still very weak.

Images and sounds have a great narrative potential which, to be expressed, need the knowledge of certain rules and grammars, as cinema, games and theater demonstrate. In the storytelling, words, images and sounds must converge in the creation of a coherent meaning (and feeling) for the spectator, each one using its own expressive means. Usually the story construction is a long and collective process that continues to be improved and reshaped until the final production: once all the historical or archaeological information has been acquired, a process of abstraction, subtraction and synthesis begins, aimed at distilling the essence. Some messages are made explicit, others implicit or subliminal [Galansino and Perov 2017].

The museum should be able to exhibit the artwork favoring the perception of its aesthetic consistency, but also the understanding of the cultural context in which the object has been originated: a process of readability, critical interpretation and elaboration of the meaning [Arnheim1954; Brandi 2000]. This is not obvious, because many artworks or cultural objects have lost their ability to be recognized and understood by the visitors. Their sensory dimension, their context, or their narrative value are almost inaccessible, also depending on their state of preservation and on the criteria of taxonomy followed by many exhibitions. In contrast, a tale is a sort of “reconstruction” of the object; it implies choices, both in making its form legible and identifiable (through a virtual restoration for instance) and, also, in reconstructing its context, meaning, and sphere of life [Antinucci 2014].

### Storytelling and reliability inside museums

A story is a bridge between reality and imagination [Salmon 2007]. Usually museum curators prefer to be “neutral” regarding the artifacts, and they avoid telling or suggesting the visitors anything else beyond the pure evidence. Lives, emotions, context of usage, or interpretations are in most cases missing because not sure. Unfortunately, avoiding interpretations is not a neutral choice: if a visitor is left alone, without any support suggesting meanings and contexts of usage (that means interpretation and “reconstruction”, even if hypothetical), he/she will be free to understand and deduce everything, even false and erroneous significance. Omission is not positive [Antinucci 2014]. In the creation of a narrative, certain and circumstantial contents regarding the artifact will be combined with plausible and probable ones, the latter pertinent to its cultural context but not completely sure for that specific object. An example will clarify this assumption. In the next paragraphs, a case study will be discussed in relation to our holographic showcase. It is the story of the Kunàgota sword, preserved in the Hungarian National Museum of Budapest. In this case there are, as starting points [Pagano et al. 2018]:

- a) Certain information related to the object itself: the sword was discovered in an Avar tomb of the 7th century AD, near the village of Kunàgota, Hungary; it was part of the funerary good of an Avar warrior, it has been adorned with golden sheets showing figures coming from the Byzantine iconography and style. Such kind of decorations and figures can be often found on precious Byzantine caskets, of which there are many examples. These golden sheets have been broken and mounted chaotically on the Avar battle sword, being adapted to its different parts.
- b) Certain information regarding the general historical context of the Avars: they were a population of warriors, they were often fighting against the Byzantines, they practiced looting; they believed in the afterlife, in the Blue Sky of “Tengri” (according to a shaman tradition of central Asia from where they originated).
- c) Plausible and probable contents: the style and the dimensions of the golden sheets let us suppose that originally they could belong to a precious small Byzantine casket, for instance to contain jewelry. It is historically credible - even if not certain in this case - that the Avars took the casket as a looting, after winning a battle against the Byzantines. As the golden sheets were broken with a scant attention for the integrity of the figures, it is possible also to suppose that this work was made by an Avar goldsmith who did not understand the identity and the meaning of the figures. The sword was really used for war, so it can be assumed that the goldsmith made this work when the Kunàgota chief died, to adorn his sword in gold, before including it in the tomb.

Putting together these three levels of contents, a visual storytelling has been built, with soundscapes and characters (of whom user can hear the voices and see only the hands during the different actions) (Fig. 1a). Events have been dramatized and represented while happening: the small casket, containing jewelry is in a rich Byzantine house; the battle is ongoing and the casket is taken away by the Avars; the Kunàgota chief is dying on its deathbed and he talks to his son, asking him to make the sword adorn in gold and put it in his tomb; the goldsmith in its workshop, with his assistant, cuts the sheets and fits them on the scabbard, trying to understand what kind of figures they are; finally user can see the tomb connected to the Blue sky of Tengry (represented according to the original Avar iconography), from where the spirit of the Kunàgota chief speaks to us for the last time<sup>1</sup>.

It is a very plausible story, even if some parts are imaginary. Nobody can say that this reconstruction is wrong (unless an expert will discover new evidences clearly contradicting it). [Antinucci 2014].

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<sup>1</sup> <https://vimeo.com/236305120>



Fig. 1. a) Holographic showcase with the Kunàgota sword inside, Allard Pierson Museum, Amsterdam, 2017; b) Holographic showcase with objects of the Mytilene treasure inside, Byzantine and Christian Museum, Athens, 2018

### The holographic techniques and the illusion of reality

Digital applications presented inside museums are commonly juxtaposed to real collections but not sufficiently combined and integrated with the museums' contents and the visit pathway.

Thus they do not completely solve the main issue of museums: communicate and contextualize the artifacts and their cultural message [Pietroni et al. 2019].

The intent of creating a "dramatic dimension" inside the museum showcase has recently brought us to experiment and apply an ancient representation technique, called Pepper's Ghost. It consists of an optical effect, similar to a hologram, taking place inside the showcase, in presence of the real artifact and interacting with it, producing a mixed reality.

Thanks to holography, it is possible to duplicate reality, create characters, objects, or scenes that do not exist and make them seem as they were in front of our eyes.

Real holography that is based on the use of coherent laser light appropriately projected, as theorized in 1947 by the Hungarian scientist Dennis Gabor (1900–1979), is still technologically not mature to be applied to performative arts, cinematic and multimedia. Thus the most used technique is Pepper's Ghost [Steinmeyer 1999].

The English scientist John Henry Pepper (1821–1900) brought some techniques, already invented in the 16th century in relation to *camera obscura*, on the stage of theaters to create magic effects, fascinating the spectators. The illusion consists in the perception of things, a place or a floating figure in the empty space, in a position where they are not in the reality - given that their real presence is in a secret place, hidden for the observers, located under the main stage or aside [Pepper 2012]. In this hidden room, real figures (characters, objects) moved in front of a powerful source of light. Once illuminated, these figures were reflected by an oblique mirror that was positioned with a corner of 45° between the hidden room and the spectators. Because of an optical effect, the reflected image was automatically projected on the stage. In this way, it was possible to create ghost effects - an illusion of reality. Virtual reality enters our space without the use of special devices.

Today Pepper's Ghost effect can be easily produced using digital technologies (Fig. 2). It is appropriate and easy to implement inside museums, in terms of integration with original artifacts, image quality, compatibility with preservation needs, scalability, adaptability, robustness, daily management, costs.

The use of holograms does not aim only at producing astonish reaction in the visitors for its magic. Through the hologram it is possible to change the traditional paradigm: if one includes the real artifact inside the holographic showcase, the attention still remains focused on the real artifact. Not its virtual replica, but the original itself, is the center of our attention throughout the experience: all the virtual animations, the fragments of stories originate from its real figures and details, thus creating an experience of mixed reality.

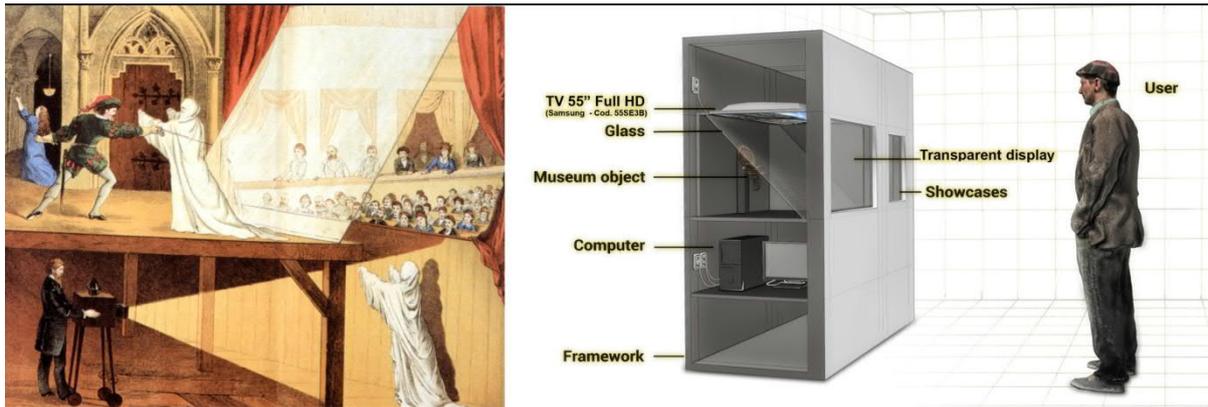


Fig. 2. a) Drawings showing Pepper's Ghost in theaters in the 19th century; b) Structure reproducing the same effect through digital equipment

### The CEMEC project: the box of stories

The experimentation with holographic showcases has been carried on in the framework of the European project CEMEC (Connecting Early Medieval European Collections), still in progress (2015-2019), where universities and research institutions, museums and technical partners are cooperating to advance in the knowledge and promotion of the Early Medieval arts and cultures of different European regions and, also, in the museological sector [AA.VV. 2017]. This is done through the concrete realization of an exhibition traveling among the museums, where the holographic showcase has been presented and evaluated in relation to its impact on the public.

Efforts have been oriented on the creation of a holographic showcase, the so-called “box of stories, and on the definition of a coherent communicative format, where (a) integration of real and digital contents (b) structure (c) materials (d) interior setup; (e) illumination (f) perception (g) audio-visual grammar, (h) narrative approach, and dramatization (i) scalability are designed as a whole.

As already mentioned above, the virtual contents are projected in the same space of the real object and bring it back to life, to its sensory dimension, following a “dramaturgy”. Real and symbolic scenarios can be evoked and represented, accompanied by emerging personages, voices, and soundscape.

This holographic showcase is rather demanding in terms of space, but its multimedia potential is great. First of all because of its dimensions: the front window is 120 cm wide, the depth is 140 cm, the height 80 cm. Up to 5 or 6 persons can see it at the same time and it is possible to simulate many events inside of it. Users can see more than one real object (or one big object). The inner space can host even a simple physical scenography and virtual characters can be projected in real scale. Fig. 1b for instance shows how a real candle holder exhibited in the showcase is incorporated and contextualized in the virtual scene and thus brought to life.

The box of stories can be also integrated in a wider projection wall (4 meters wide), so that it is possible to alternate virtual animations inside the showcase or extending outside. This specific research has indeed evolved engaging experts in humanities, museology, psychology, curators and artists, engineers, working together and supported by the user experience evaluators. This integration has helped us to define some general guidelines, constituting the innovative value of this proposal [Pietroni et al. 2019].

### The Kunàgota sword & Mytilene treasure

The box of stories has been used to tell the story of some objects of the 7th century AD which are:

- The *Kunàgota sword*. An Avar sword exposed at the National Hungarian Museum of Budapest (NHM), of which has been written in chapter “Storytelling and reliability inside museums”.
- The *Mytilene treasure*. A set of 70 Byzantine objects from the Byzantine and Christian Museum (BCM) of Athens [Touratsoglou and Chalkia 2008]. They belonged to the wealthy family of a high official of the Byzantine administration, that lived on the Mytilene island, in front of Asia Minor coast. These objects were part of the domestic equipment. The sudden danger of an enemy attack could have obliged this family to bury the precious objects into the ground, to preserve them from possible looting. Three representative objects of the treasure, a golden bracelet, a candlestick and a *trulla* (a tool for water's spilling), have been included in such a box of stories.

In the holographic showcase, each object has been presented alternating (a) a short presentation, with a more descriptive style, to communicate the basic information (so called “neutral vision”); (b) a dramaturgy, which means scenarios where each object is contextualized in its original environment and shown during its daily usage. They are evocative and symbolic and combine 3D graphics and real actors (in the case of the Mytilene treasure). The *trulla* and the bracelet have been printed in 3D to be used by actors in their fiction.

## RULES AND CONSTRAINTS TO CREATE GOOD HOLOGRAMS

As the holographic effect is an illusion of reality, in the concept of a showcase using Pepper's Ghost effect in a museum, there are specific rules and constraints that need to be respected, in the environmental conditions, in the setup of the structure and in the adopted visual grammar.

### Environmental conditions

The quality of visual effects depends in particular on two aspects: a) the credibility of the images (see chapter “Visual Grammar for the ‘ghost’”) and b) the environment without visual, geometric or luminous interferences that can reveal the projection techniques and therefore the magic.

The environmental conditions inside the showcase, even if extremely controlled, cannot be completely independent from the outside. The museum environments are different and always changing and they cannot be easily be modified. Some expedients have been studied and adopted to minimize the influence of the exterior on the interior space, like internal masks, black and non-reflecting internal coverings; filters on external lights directly impacting the showcase. Being able to guarantee an area of partial darkness around the frontal window of the showcase helps both to improve the quality of the ghost and to more effectively hide mirrors, lights or internal reflections.

### Set up of the holographic showcase and visibility of the real objects

On a practical basis, when designing holographic showcases, the visual quality of the overlapping between real object and the digital content depends on the materials used to produce the ghost effect in addition to the interior design of the showcase (i.e. lights, dark area, and relative position of the observer).

The image of the ghost can be broadcasted through a monitor (as in Fig.2) or by a projected image on a white screen; the 45° reflective material can be a glass, a Plexiglass, or a film to be mounted on a frame. In addition, the holographic case, like any other museum showcase, must be closed frontally by a strong transparent glass to protect the object.

For the CEMEC project, a 4K monitor, positioned on the ceiling of the showcase, transmits the image that is reflected by the semi-reflecting glass (4mm of thickness). A transparent shatterproof glass (8mm) closes the window on the front side. It does not create particular problems of visibility, even if it is necessary to pay attention to the reflections of the area in front of the showcase (Fig.3a). The reflective surface is a special 4 mm thick glass, which has the characteristic of having one of the highly reflective surfaces preserving a good index of transparency.

For a different and more direct vision of the object, alternative scenographic solutions were also tested, such as making the showcase background transparent. The technology usable here is the transparent Oled (Organic Light Emitting Diode) panel which allows to control the back transparency (Fig. 3b). If the spaces of the museum would allow the passage of the users in the back of the holographic showcase, this solution would guarantee on one side (from the back) the direct vision of the object without any interference of the holographic image. Whereas, the viewers place in front of it, would see the real objects, the holographic projection and a third level represented by what is beyond the window (the audience or an *ad hoc* outdoor scenography).

The object contained in the showcase has different ways of being part of the story: appearing by illuminating it with directional spots, disappearing by switching off the spots, vanishing behind the projected holographic image. Lights are therefore part of the dynamic compositing of the story. Finally, regarding the position of the observer with respect to the object, it is good practice to guarantee a tolerance zone on the front of the display window of a minimum of 50 cm, an ideal position both for perspective reasons and for scene requirements.



Fig. 3. a) Lateral picture of the holographic showcase with 45° glass, back objects and frontal glass clearly visible; b) effect produced by the transparent glass at the back of the structure

### Visual grammar for the “ghost”

Visual grammar is related to the layout of the virtual animation inside the holographic showcase. Indeed in presence of the real objects, the designer of virtual contents has much more constraints to respect to create a convincing integration and a perfect mixed reality. These are some constraints [Pietroni et al. 2019]:

- *3D graphics*: 3D is recommended to create a better illusion of reality.
- *Background*: virtual contents must be like apparitions floating in the empty space; usually a black background in the digital animation is suggested.
- *Image contained in the frame*: The illusion of reality imposes that virtual contents should be entirely contained in the frame, without cuts on their borders, as it happens in the stage of a theatre but differently from a cinema movie).
- *Scale*: when a real object is inside, the scale of the holographic projection needs to be real, correctly proportioned to create a precise correspondence between real and virtual contents.
- *Position of the real object on the stage*: The reflected image (ghost) lays on a well-defined plane of projection. The real object must be positioned in correspondence of this plane in order to create a perfect overlapping with the virtual contents and thus the illusion of reality.
- *Still camera*: Due to the illusion of reality, a unique camera position (coincident with the visitor’s eyes) is needed.. Multi-camera would bring the visitor in a different experience recalling cinema.
- *Point of view, Field of View and Depth of Field*: it is important to keep a coherence between the point of view of real and virtual contents. Everything in the scene must be in focus, because of the illusion of reality.
- *Matching of lights and colors*: It is very important that virtual lights and shadows, set for the ghost, match with the real ones in terms of intensity and color.
- *Essentiality and charm*: In the holograms, less is more, rhythm is very important.
- *Sound spatialization*: sound spatialization (stereo, Dolby surround) is possible if the dimension of the holographic showcase is large enough and the space of the sound projection is wide.

## INTERACTING WITH TECHNOLOGY INSIDE MUSEUMS

In recent years, it has been possible to see how new technologies have expanded the dimensions and capabilities of museum exhibits, turning visitors from passive observers to actively engaged participants. The holographic showcase is one of these and tries to set both museum curators’ requirements and audience’s expectations [Mancoff 2016].

In the holographic system, users can passively take part at the storytelling happening in front of them or become active by physically interacting with the content through buttons or special devices connected to the audio visual system.

There is not a unique solution in all museum contexts in term of interaction with holographic showcases, because this depends on the available museum space, the visitors’ flow, the museum visit path and the type of target (children or families or experts...); nevertheless, interaction has to consider the kind the storytelling, the length of the story, and the general atmosphere provided to the users.

### Active vs. passive museum visit

Compared to the didactic expository model (where the visitor can only receive information passively), interaction techniques turned out to be important tools in the exhibition design to improve the museum visitors' participation through open-ended activities. How interactivity can influence the type of museum experience? This aspect is strictly connected with the setup of the cultural institution hosting the digital product, and its location along the museum visit path.

Specifically about the holographic showcase, particular care should be taken in the design of the structure, in case of its integration along the visit pathway or in case of an entirely dedicated room. In fact this technological solution can be set up both interactively or with no interaction at all. In the former case, simple modalities can be applied as language selection and chapter's story selection; something more interactive can be the manipulation of 3D objects inside the showcase by mean of external sensors. In the latter case, instead, only the enjoyment of audio visual content is possible with the integration of a dynamic lighting system or inner mobile scenes like theatrical setup.

### Interacting with the holographic system

In the case of the holographic showcases developed within the CEMEC project, it was necessary to conceive a communicative format that could easily adapt to the different spaces and visit paths of the museums in which the traveling exhibition was hosted. In the first venue (Budapest), a dedicated room was available, containing only the holographic showcase; in others, instead, the holographic showcase was located along the museum visit paths. Therefore it was decided to give preference to the narrative aspect rather than to the explorative/interactive ones. This choice was also determined by the desire to experiment and push to the maximum the expressive and narrative potentialities of the holographic showcase, enhanced by the mixed reality environment.

In the holographic showcase using Pepper's ghost, interaction is implemented at two levels: a) author- system and b) public-system. The first and more complex level consists into the author/director's ability, through specific software, to easily control and modify the scenic mechanisms, to calibrate the superimposition of real and virtual contents, and to organize the play out of the contents. Based on VVVV platform<sup>2</sup>, this software helps to manage and synchronize all the events that are about to happen in the showcase. Multiple channels (video, audio, lights, and activation of scenic mechanisms) are organized in a "score", along a time line. In such a way the integration of the different elements to be played can be easily modified during the preparation and optimization of the narrative sequence, without editing the single contents, but only operating on the score. Some parameters can be exposed and controlled by keyboard (or MIDI controller) so that it is possible to simulate real-time events and make the creative process much faster.

The second level, the user one, even though the system is designed to support complex interactions, a very simple solution has been implemented, limited to language selection through an external push-button panel.

## USER EXPERIENCE EVALUATION INTO CEMEC MUSEUMS

Evaluating the experience visitors make in museums with digital applications it is essential to understand what works and what not in terms of communication techniques, social participation, and cultural learning in each individual. "User eXperience" (UX) is composed by multiple factors which include the context and the conditions of fruition, the emotional and cognitive domain of the evaluated person and the technological domain of the proposed solution (in terms of interaction, content and usability).

For the holographic showcase, several evaluation have been carried out during the CEMEC project, trying to point out (a) the general feedback of users (appreciation and satisfaction); (b) the usefulness of contents told in such a manner (holography upon real museum objects); and (c) feasibility of the system into museum contexts [Pietroni et al. 2019]. Evaluation took place in Budapest (National Hungarian Museum—NHM), Amsterdam (Allard Pierson Museum—APM) and Athens (Byzantine and Christian Museum—BCM) during the itinerant CEMEC exhibition. Museum staff and CNR researchers followed the evaluations using the "multi-partitioned analysis", which addressed to identify and evaluate the impact of storytelling within the holographic showcases. For APM and NHM the evaluation was done on the holographic showcase hosting the Kunàgota sword; while at BCM the subject was the Mytilene treasure. The evaluation method used two techniques:

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<sup>2</sup> <https://vVVV.org/>

- *Observations:* They allowed us to have an overview of the users' behavior toward the holographic showcase in terms of visibility of the digital product along the museum path, user's attitude toward it, time of permanence in front of it, type of visit (single or group), attention or distraction while watching the story inside the showcase, need for help to make the story starts.
- *Direct questionnaires:* They gave the chance to gather direct feedback of users to confront to what just observed by operators, finding a common sense and interpreting users' reactions putting comments into contexts of reference.

After 2 years of investigation and about 450 observed visitors and 280 interviewed, results confirmed the role of digital storytelling in museum learning experience and the relevance of emotional involvement in the process of meaning-making of the cultural contents. Some specific aspects are discussed in the following chapters. Just to summarize briefly, as reported in Pietroni et al. [2019], users were mainly women (51% out of the global users), around 60 years old (45% out of the global users), coming from Europe (northern countries). A great interest toward the new narrative approach and the holographic system has been registered for the Kunàgota sword, in the Hungarian and Dutch venues, and for the Mytilene treasure in the Greek location. In all cases, a marked sense of curiosity has been recorded: after observing the Kunàgota showcase visitors seemed satisfied and fascinated from what they have just experienced. The same goes for Mytilene treasure: the drawings and characters captured the attention and interest of all target groups, stimulating a sense of wonder in the eyes of the audience as resulted from the open comments.

What about the real object included in the holographic showcase and the related digital narrative forms? Do they match together producing an understandable vision of the Past? Is the real object well illuminated and clearly visible to visitors? Is the function, the decoration and the story of the museum object evident though the digital replica or not?

### Real objects and virtual replicas: enemies or pairs?

As already expressed in the chapter about the visual grammar of the ghost, in order to obtain the most credible and emotional effect out of the holographic showcase, all the forms and the storytelling created around the physical artifact need to be well calibrated and have to happen upon or nearby it. This is because users - perceiving the exact collimation between real and virtual, the ancient object and its digitally restored version - start imaging how it would have appeared in the past [Miyamae 2013].

Events like the context of fruition, its usage and its function cannot be reproduced on the real object for several reasons (conservative, security, etc.); nevertheless, the digital replica can do it. So, virtuality in such cases helps visitors grabbing the sense of the exposed museum object while appreciating its value and understanding its function.

### Visibility of museum objects

In the chapter "Set up of the holographic showcase and visibility of the real objects" the light functioning has been well explained. Due to technical constraints, lights inside the holographic showcase are directional respect to the object's position, while the environmental lighting are often not controllable due to museum constraints; in general lights are weak but some reflections still occur on the frontal glass of the holographic showcase. Information collected out of the evaluations reported that, in some cases, visitors were prevented to clearly observe the artifact due to the technical distance between the object and the frontal glass, provoking a sense of frustration and disappointment. In general, at the NHM, 65 % of users considered the visibility as good and also the lighting system (87 % said it was working well); at the APM, the percentages were higher with 82 % of users appreciating the visibility of the objects and 91 % of them noticing the good lighting system. In BCM, due to the different artifacts exposed, the reduced dimensions of the bracelet of the Mytilene treasure really influenced the visitors' opinion: only 57 % of them said that the visibility was good. Therefore, selecting the appropriate object for the holographic showcase means also taking into consideration dimensions and distance from the user's point of view in the museum room. A solution to overcome this problem can be a) to improve the light intensity and the object's illumination; or b) to use a transparent or semitransparent glass at the back of the holographic showcase, as mentioned above: this may allow visitors to see closer the museum objects, without any projection on them.

### Readability of museum objects

The use of holographic showcase inside museums is an attempt to answer the need of bettering the museum objects readability, given the possibility to mix together real artifacts and its digital replica. In the case of the CEMEC museum objects, the digital replica served various scopes:

- a) to analyze the virtual reconstruction of the *trulla*, ruined and with missing parts;
- b) to visualize the virtual restoration of the Kunàgota scabbard with gold sheets, where time has damaged its original colors and decorations;
- c) to confront the result of studies on reconstructions and restorations along the time, like in the case of the Kunàgota's casket;
- d) to appreciate the details of the Mytilene bracelet, through enlargements and highlights of some part of the digital replica;
- e) to visualize the construction techniques of the Kunàgota sword's decorations.

During the UX evaluation, people commented “Beautiful to see the explanation of the museum object appearing so intensively in front of our eyes and have the chance to attend it with all my families” and “Absolutely clear how the *trulla* was used in the past, it was unknown to me until now”. These sentences give the feeling of how powerful holography is inside museums.

### Understandability of museum objects

Visibility and readability are much connected with the understanding of the museum objects included inside the holographic showcase. Results coming from evaluations confirmed this intuition: regarding the content delivered, the majority of visitors paid great attention to the story; of the five questions about historical information, visitors reached almost the 80 % of correct answers both at APM and HNM while at BCM was registered a 93 %. The visitors' memorization rates were indeed high, especially if these results are matched with the ones coming from questions about elaboration and recalling of units of content, again favorable. Operators also noticed that once they finished the questionnaires, 40 % of APM visitors returned to the showcase to verify if they have correctly answered – showing their sincere interest toward this research and a great sense of curiosity. At a direct request, 74 % of visitors liked the storytelling at NHM, compared to 97 % at APM and 86 % at BCM.

## CONCLUSIONS

Currently with museums increasing their audiences, updating visitors to participants and trying to make collections more user-friendly to the public, more sophisticated – technically as well as methodically – digital technology become an important part in the process of participatory the visitor.

Technology is a mean which helps us shaping the involvement in the digitally augmented reality. Public is usually attracted by the technological solutions. However, several surveys carried out inside museums or exhibitions, observing the people's behaviors, showed very clearly that the attention towards tools and devices is not long-lasting; it rapidly decreases if the cultural contents and narrations are not able to keep it alive and, similarly, if the interaction is difficult and not natural.

For such a reason, it is necessary to rethink technologies at a deeper level of usage. But how? By working on the cognitive and emotional domains! The emotional component is fundamental in museum learning experience because it is the “irrational” part of human being and it generates motivation – the first aspect that pushes people to face technological solutions and lets the learning process to take place.

Traditional museums have played an important role in making connections between different objects across time and space. Now they have to elaborate the stories around these collections to create a connection with their different audiences. They must multiply the layers of meaning and place greater emphasis on different perspectives. Valued both as a preserver of memory and instigator for ideas, they will empower people to seek answers and foster action.

To reach such a purpose it would be recommended to integrate into the working teams screenwriters, directors and scenographers, and musicians. The museum could thus become a place where it is possible not only to look at objects, but also to listen to their stories.

## ACKNOWLEDGEMENTS

This research project is funded by EU Programme “Creative Europe - Culture, Cooperation Project” of EACEA. G.A.2015-1143/001-001 (2015-2019). Acknowledgements go to our colleagues from CNR Daniele Ferdani and Leonardo Rescic, Claudio Rufa and Massimiliano Forlani from E.V.O.C.A., to all the CEMEC partners and in particular the HNM, APM, BCM museums.

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*Imprint:*

*Proceedings of the 23rd International Conference on Cultural Heritage and New Technologies 2018. CHNT 23, 2018 (Vienna 2019). <http://www.chnt.at/proceedings-chnt-23/> ISBN 978-3-200-06576-5*

*Editor/Publisher: Museen der Stadt Wien – Stadtarchäologie*

*Editorial Team: Wolfgang Börner, Susanne Uhlirz*

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