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Activity 3.4
Policy studies, consultation and recommendations

Deliverable 3.4.3
Reports on reccomendations about the experience design for the realization of KACs and Underwater Museums

October 2017

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Programme cofinancé par le Fonds de Développement Régional
Programme co-financed by the European Regional Development Fund

Summary

This report provides recommendations for the experience design of KACs and Underwater Museums and a summary of the best practices and technological development in the field of user experience for the Cultural Heritage.

1. Introduction

Museums have been going through major changes over the past 30 years, beginning with a major re-orientation of the primary goal of a museum at the end of the 1970s which at the time was termed "the new museology." Some argue that the movement arose from the International Council of Museums redefinition of museums in 1974 (ICOM, 1974), others from Peter Vergo's edited volume of the same name (Vergo, 1989). The goal of the new museology was, and largely still is, the transformation of social practices through the transformation of the museum from a collection of singular expert accounts to a site of different educational engagements. This has led to the shift from “object-centered” institutions towards “visitor-centered” institutions (Hein, 2000). The new positioning of visitors at the heart of institutional strategic planning means they have to be taken into account in every step, from architectural layout to exhibition design.

The first effort toward this end was the development of interpretive aids, such as brochures and audio guides, but these are limited and do not offer to the visitors the possibility to explore artifacts both broadly and deeply as they go through an exhibition.

Since the “visitor-centered” approach is not merely a missed opportunity; many institutions realize that in order to prosper, they must change by providing more engaging and informative visits. They then can no longer satisfy themselves with merely preserving and displaying important collections, confident that the public will continue to find value in repeat visits (Cembalest, 2009).

As a consequence, in the last years, museums continuously explore new ways to improve the visitor experience and revise the traditional ways of presenting the collections and information, expanding their current practices. Museums, in fact, are most effective when

they take the experiential qualities one tends to associate with theater and fiction: an experience of other people's dramas and dilemmas, those not necessarily rational but certainly universal aspects of the human experience (Mouw et al., 2007).

This transformation has been accompanied and exacerbated by the pervasive and global introduction of new technologies that, as detailed in the next section, can profoundly change the connection of visitors with the institutions and their offerings.

Today, the efforts to comprehend the visitor experience are no longer new but are far from reaching maturity. However, there is an unsuspected and apparently unrelated field of knowledge that may serve as inspiration and make a beneficial contribution to the study of the Visitor Experience – the User Experience (UX) within the research on Human-Computer Interaction (HCI) (Pallud et al., 2010). HCI, as the name indicates, concerns the design and use of computer technology at the interface of users and computers, with UX having an emphasis on the human experiential feelings and preferences. The affinity between Visitor Experience and UX is mainly pertinent in museum settings where technology is prevalent and plays a major role in facilitating the connection of visitors and the collections on display, which is a recurrent situation in today's institutions. With the integration of computers, mobile devices and overall interactives into the museum exhibition space, previously inexistent conflicts developed as the offspring of the new ways to mediate experiences (Marques, 2017).

In particular, visitor experience pertains the interaction between the visitor and the products and services provided by the museum. The museum product is delivered in a physical environment that is defined by its layout, lighting, means of orienting the visitor, queues, etc.; and its service is conveying information and engaging with the visitor by resorting to methods that stimulate interest (Goulding, 2000). Museums can create the physical and social environments or circumstances in which visitors have an experience, but the experience itself takes place inside the individuals as their personal response to the encounter with the exhibition.

The importance of the experience design applied to the cultural heritage has been demonstrated also by the introduction of specific educational programs in some universities that distinguish themselves by the degree to which technology and UX are central to the curriculum. These are the Cybermuséologie program at the Université du Québec en Outaouais and the Museum Studies Program at the Johns Hopkins University. Furthermore, many museum studies programs carried out in various universities, all over the world, have integrated courses pertaining to technology into their curricula to instruct students on museum informatics, digital imaging, virtual museums, interactive technologies, development of new media products, computer-aided drafting, alternative techniques for visitor/computer interaction etc.

2. Technologies enabling visitor experience

As above mentioned in the previous section, as new technologies emerge in the market, museums are able to enhance visitor experiences through innovative tools, allowing for increased accessibility and interaction with the visitors. The infusion of technology was such that very few museums today exist without some form of interactives in their exhibitions, and it is increasingly rare for a visitor to have an entirely passive experience (Marty, 2007). Furthermore, while some studies indicate that digital technology can be a distraction, there is considerable counterevidence that when it is properly designed, it can actually increase visitor's engagement with other exhibits (Gammon et al., 2008).

What visitors come across more frequently is a range of new media technologies, from high definition video and animation, that include music and sound effects, touchscreens with games and 3D modeling manipulation, and a host of other interactive experiences. Even if the basis of most exhibitions is still the conventional tool of storytelling, visitors are pulled into the stories through multisensory digital experiences that are as much about feelings and emotions as they are about knowledge and cognition (Pallud et al., 2010).

It follows an introduction of the technologies that have been successfully designed to elicit an emotional reaction, such that it may be said to generate an "experience", of the museums' visitors and change the way museums can present their exhibitions.

2.1 Mobile technology

As above mentioned, museums are investing in technologies to make the museum experience more interactive, even working with mobile technology that guests carry with them. Mobile technology is, indeed, one of the oldest forms of technology in cultural institutions that currently is synonymous with visitors using their own smartphones and tablets in museum exhibitions.

Usually, this kind of interactive experience, in which users adopts their own personal devices, requires a free Wi-Fi connection throughout the building that allows guest to access to more information and audio guides, while at the same time uploading images to social networks. In addition to Wi-Fi connection, also RFID and Beacon technologies can enable content on guests' smartphones and tablets. These contents can be exploited by means of multiplatform apps that provide multimedia information, audio, and images, maps, 3D contents, and also augmented reality interactions. In particular, RFID technology enables automatic identification of objects and Beacons are a location-based technology in the form of small wireless sensor. The Beacon technology offers the opportunity to trigger interactive and immersive moments on visitors' devices when they go through museum spaces equipped with beacons. When a visitor walks in the proximity of a beacon with their Bluetooth-enabled devices like a smartphone, the beacon automatically sends messages, contents to the visitors' devices to engage them in new and exciting ways. For example, the Brooklyn Museum is using Beacon technology as a way for guests to interact with museum experts while Museum of Modern Art in New York, and Guggenheim are also testing beacon-based location technology.

In conclusion, personal mobile devices provide a platform for interactivity and access to an unlimited amount of information, presentation of rich media, and flexibility for customized experiences both inside the museum and beyond.

As an alternative to smartphone and tablet devices, some museums provide users of handheld devices such as the Louvre-Nintendo 3DS XL Audio Guide that guides visitors by tracking their position on an interactive map and providing them audio commentaries, 3D reconstructions and HD images.

Figure 1. 3DS XL Audio Guide of the Museum of Louvre (Paris) (credits http://louvreguide.nintendo.com).

2.2 Interactive displays

In order to go beyond a smartphone and tablet application, some museums provide to their guests HD or 4K touchscreen displays. These technologies allow user to exploit different kind of interactive experiences. Visitors can pull up HD images and information from the museum's collection can visualize and interact with 3D objects and artifacts, many of them that are not exhibited; or can draw line and play educational games.

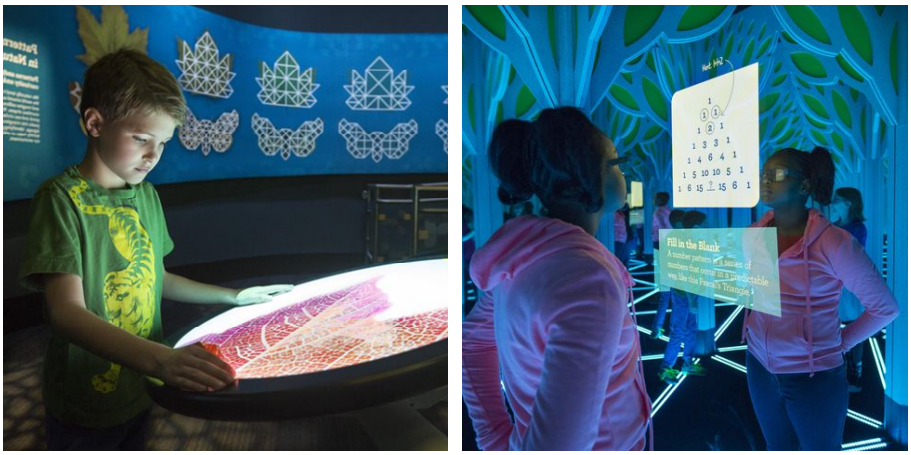

Figure 2. Interactive displays at Museum of Science and Industry of Chicago (credits www.msichicago.org).

The interactive display can be of different size and shape (rectangular, circular, etc.) and can be fixed to the walls or on pedestals and then placed throughout the museum. The kind of interaction can occur by means of direct or indirect touch, with single or multi-users.

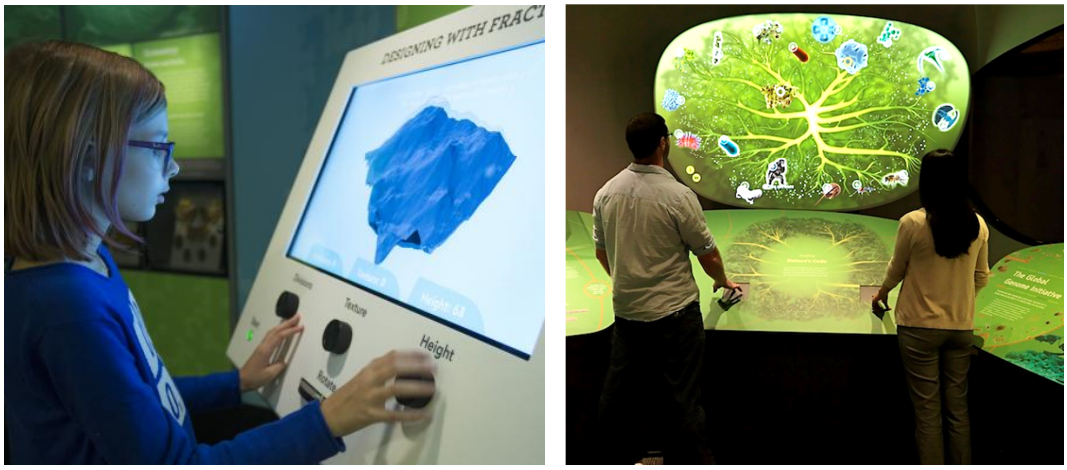

Figure 3. Interactive displays (left) at Museum of Science and Industry of Chicago (credits www.msichicago.org); (right) National Museum of Natural History of Washington (credits https://naturalhistory.si.edu/).

The displays are designed to be adaptable, with physical pieces and digital content that can be rearranged and replaced so that the displays can change as the field advances. As depicted in figure 3, the largest display can accommodate simultaneous users.

2.3 Large screens

Figure 4. Large screens (left) at Museum of Science and Industry of Chicago (credits www.msichicago.org); (right) New York Hall of Science (credits http://business.panasonic.com).

Edge-blended projectors, which number depends on the screen size, allow to create a seamless and immersive visitor experience (fig.4). The projectors display the animations on long curves walls and, sometimes onto the floor in order to improve the level of immersion of the visitors. In particular, the addition of motion-sensing technologies enables both physical and digital interaction to enhance the experience provided to visitors (fig.5).

Figure 5. Large screen with motion-sensing technology at Museum of Science and Industry of Chicago (credits www.msichicago.org).

2.4 Projection mapping

Projection mapping is a projection technology that turns a non-flat object or landscape into a display surface for video projection. Projection mapping is generally used for outdoor installations, but it can also be used to enhance visitor experiences with museum collections.

The experience provided by means of projection mapping can allow visitors to experience how temples and status have looked like in their original polychromatic form and to enjoy their vivid colors and patterns (fig.6).

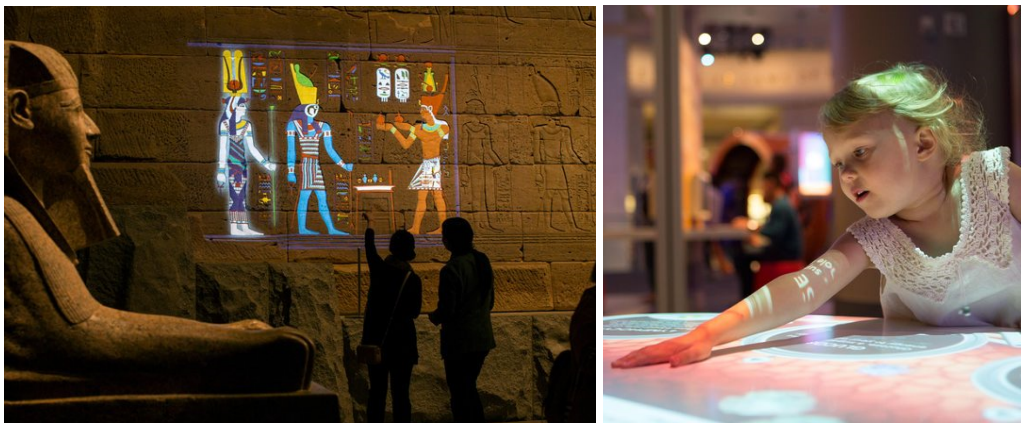

Figure 6. Projection mapping at (left) Metropolitan Museum of Art of New York (credits https://www.nytimes.com); (right) Museum of Science and Industry of Chicago (credits www.msichicago.org).

Figure 7. Projection mapping HARMONY, Japan Pavilion, Expo Milano 2015 (credits https://www.teamlab.art).

Or it can also interact with the visitors, for example, the projected images depicted in figure 7 change in line with the visitors' movements as they wander through the room. As they wander around, people can experience changes of nature that are characteristic of Japan across the span of an entire year.

2.5 Virtual and Augmented Reality

Developments in virtual reality (VR) and augmented reality (AR) have a profound effect on the ways in which museum interact with their visitors. While virtual reality provides simulations that are, completed computerized, augmented reality simulations combine real and virtual elements with which visitors interact. The common link between these two technologies is represented by interactive 3D objects and environments that are regarded as a key area of research and development towards information-rich representations of heritage objects, buildings, sites, etc., and new forms of mediating cultural and historical knowledge (DigiCULT, 2004). But, what is worth to notice is that not all the virtual and augmented reality experiences provide for the same amount of interactivity. For some of them, interaction is limited to the simple act of turning ones' head and looking around. In others, the method of interaction is unique and complex.

In a similar way to augmented reality, virtual reality opens up a space for alternative curation but, whereas augmented reality can make any space a gallery, virtual reality allows its artist to create any space. In particular, virtual reality has been harness by museums for the purpose of what Mannion called "interpretive mediation" (Mannion, 2011). The Amsterdam Van Gogh Museum was the first in the world to feature paintings brought to life through Virtual Reality. During the 2015 Museum Night, visitors were invited to Van Gogh's and Munch's bedrooms by the painters themselves (fig.8). For this production, Veejays.com's Ivo and Hunter joined up with several partners, including the Van Gogh Museum and Shosho. Thanks to the adoption of virtual reality visitors were able to step into the painting itself and walk around. Visitors enter into virtual reality using 3D glasses (Google Cardboard) and a specially developed smartphone app.

Figure 8. VR experience at the Amsterdam Van Gogh Museum (credits Veejays, 2015)

Another example is that provided by the National Museum of Singapore, where, having put on VR glasses, visitors can walk through the Jupiter virtual hall and, using a joystick, approach any masterpiece, and listen to information about the history of its creation, creator and art style, thus feeling like visiting a real museum (fig.9).

Figure 9. VR experience at the National Museum of Singapore (credits State Hermitage Museum, CROC https://www.croc.ru)

AR has been the subject of experimentation by museums since the early 2000s, with promises of transforming the traditional mode of interaction between visitors and collections. Its main feature of superimposing virtual content onto the surrounding physical environment, has the potential to merge the observational and interpretational aspects of experiencing an object or a cultural site. AR can be achieved using handheld mobile devices,

phones, and tablets. But it is increasingly proposed for head-mounted display technology that fits over the eyes. Further, augmented reality technology is emerging in the area of holographic–computing, such as Microsoft Hololens, or META, which will let users negotiate 3D augmented reality with head-mounted displays and gestural interaction (e.g., reach out and grab virtual artifacts). Development of these kinds of devices is beginning to emerge and, especially in their first releases, their spread will be small because they are expensive products. In fact, the cost of developing and providing the technology is a barrier for small and mid-sized museums; however, larger museums have recently been able to experiment with the technology (Radsky, 2015). It has been estimated that about 35% of museums in Europe have already started to develop some form of 3D presentation of objects (Ng Giap Weng et al., 2011).

One example is an exhibit called “Ultimate Dinosaurs” that opened at the Royal Ontario Museum in Toronto. It uses augmented reality to add flesh to the bones of dinosaurs and lets them move around (fig.10).

Figure 10. T. rex come alive with augmented reality at Royal Ontario Museum (credits Royal Ontario Museum https://www.rom.on.ca).

As above mentioned in section 2.1, smartphones and tablets can be adopted for virtual and augmented reality application too (Kenderdine et al., 2014). With augmented reality, visitors can use a simple smartphone to discover more information about a piece of art in an

interactive manner. For example, placing a smartphone or tablet over an ancient statue could display missing parts that have broken off – giving the visitor a glimpse of how it would have looked when it was new. Because AR responds to your movement in the environment, the experience is also completely 3D.

3. Recommendations about visitor experience design

As detailed in the previous section, technology offers new opportunities to look at visitor experience in the museum sector. These potentials have been and are currently investigated and exploited by the major museums and many small and municipal museums too, to enhance their interpretive and accessibility strategies. As a consequence, nowadays, many museums cannot image their exhibitions without the adoption of these enabling technologies which (as detailed in the previous section) have numerous functions and applications: from being explanations or substitutes for essential objects unavailable at the museum, to bringing the spectator into a certain emotional state, and involving him/her in interaction with the museum space and objects (UNESCO, 2014).

Nevertheless, it is worth of noticing that even if some visitors are fixated and addicted to new technologies these represent only a tool by means it is possible to explore and develop new experiences in which the emotional response and the level of immersion are some of the key components. Then the focus is not the technology but the experience. Furthermore, the visitor experience is an ongoing process and the subject has proven to be intricate, and as complex as the diversity of human beings. There is an understanding that previous experiences, gender, age and many other factors contributing to the differences and diversity of human nature ultimately shape the outcome of an individual's visit to a museum. Some of the identified factors are personal (including visitors' existing expectations and preferences), social (related to the human connections during the visit) and physical (concerning the space and the content of the exhibitions) (Marques, 2017). The visitor experience, in fact, can be represented by a multifaced model (Packer et al., 2016) consisting of ten different factors: physical experiences, sensory experiences, cognitive experiences,

emotional experiences, hedonic experiences, restorative experiences, introspective experiences, transformative experiences, spiritual experiences and relational experiences.

When designing an experience for visitors, two main goals have to be achieved:

- engage users, trying to capture their attention, not necessarily into a immersive virtual environment;
- improve awareness and knowledge (that is the specific aim of a museum context) by instilling a sense of discovery and wonder.

In order to achieve these goals the key elements to keep in mind for a successful visitor experience are:

- the context. Although there is a lot of information that museums want to share, that information has to be shared strategically to support a positive learning experience;
- visitors should have options and be encouraged to explore.

These two key elements can be further broken down into ten factors (Russell, 2000) to consider in order to design a successful visitor experience:

1. Provide advance organizers: the experience should ease into the material and provide visitors with obvious starting points, and themed exhibits are best for visitor engagement.
2. Design accessible, attractive, inviting, involving environments: the experience must provide a safe and secure environment for users, it must be physically and intellectually stimulating, and it must be engaging.
3. Design accessible and easy-to-use exhibits: the experience should use appropriate technology/media, it should provide direct engagement, have clear visibility, be simplistic, allow for easy access to the information available within the environment, be standardized within the museum so users can generalize from one exhibit to the next, and be easy to start over in the interface.

4. Present real objects/phenomenon: the experience must present genuine and real objects that engage the user on an intellectual and emotional level.
5. Meet visitor expectations: the exhibit should be designed in a manner that is fun for the visitor, be an educational experience, encourage social interaction, engage the senses, pique curiosity, and instill a sense of confidence in the knowledge presented.
6. Provide entry points to meet individual visitors' needs: the experience should be designed to target the needs of high-priority audiences, should usemixed-media to appeal to all audiences/age groups, should provide appropriate tools for user interaction, should conduct front-end evaluation to identify target audience knowledge, interest, and reaction, and should use questions to engage users.
7. Offer visitors choices, control, feedback, and success: the exhibit should allow for built-in goals, clear paths of inquiry, layered experiences and labels, and increasing levels of complexity. The exhibit should provide continual feedback and challenges for the user, natural indications of success, and the opportunity to manipulate variables with observable results.
8. Support direct experience with labels, staff explainers, and opportunities for cooperative engagement: the exhibit must provide clear indicators for items, clear instructions, raise and answer questions, connect to other experiences, and point out thing to notice. The exhibit should provide collaborative opportunities, support conversation, and be designed for multiple participants.
9. Provide support for follow-up educational experiences: the exhibit must be connected to all aspects of the museum including web page and gift shop, and it must facilitate follow-up visits, lead to community outreach, and opportunities to work on related museum projects.
10. Evaluate: the exhibit should undergo front-end evaluation to understand the user's knowledge, interests, and preferences. It should undergo formative evaluation to aid in improving mechanical and conceptual elements of the exhibit. It should also undergo summative evaluation to assess the overall effectiveness and outcomes of the exhibit experience.

In addition to the key elements, another factor that is of fundamental importance in order to achieve the above-mentioned goals is the team devoted to the design of the visitor experience (detailed in section 3.2). In fact, an interactive relationship between a human, an artifact, and (often but not always) other humans does not guarantee the quality of the experience. Any exhibit with something to click, pull or rotate drew hands like a magnet, but normally the experience both started and ended there. In these cases, the user interface becomes a limit instead of serving as a gateway to more cerebral pleasures and discoveries (Huhtamo, 2015).

There are two general principles, which increase the chance of successful engagement: follow a set of design guidelines that have proven to be valid and use evaluation methods to assess and improve the effectiveness of exhibits (Bitgood, 2014).

3.1 Recommendations on the team devoted to the experience design

There is great variety among museums and visitor bases, so it is not safe to assume that general information or models and techniques, adopted by museums and art centers, cover all of the necessary considerations especially in the case of underwater parks about which visitor experience methods and techniques do not exist. Then, differently from a traditional museum in which the museum staff mainly focus on two figure: curators and educators, it is very important to put together a “visitor experience” staff, that, depending by the types of artworks, available content, and historical context, is able to develop and put into practice an effective and sustainable visitor experience.

In fact, in addition to curators (that generally research artifacts, choose exhibition content and write interpretive text) and educators (that take information about an exhibition and determine how best to present it to visitors in order to maximize their engagement and learning) the “visitor experience” staff should be composed by multi-disciplinary and qualified figures that consists in: a visitor experience strategist, an experience designer, an underwater archaeologist, a tourist marketing specialist, and a scuba diver expert of the underwater area in which the underwater park lies.

All these figures will contribute, with their different and multi-disciplinary expertise, to the definition of the requirements and development of the KAC and Augmented Diving systems.

3.2 Recommendations on the choice of the underwater archaeological site

The underwater archaeological area that can be defined appropriately for the implementation of an underwater museum has to satisfy various requirements.

The underwater environment, in fact, in which the archaeological remains lie on the seabed should be characterized by excellent weather conditions and climate which encourages diving through out the whole year. The underwater site should not be characterized by strong currents that put in danger the divers or make the exploitation difficult. The water quality also should be verified in order to assure always a good visibility of the remains.

The depth from the sea level of the underwater museum should not exceed the 40 meters for recreational divers. While for the technical divers is it possible to dive up to 90 meters. The scuba diving certification of each tourist-diver has to be coherent with the depth of the submerged archaeological area. Or as an alternative, where it is possible, settle two or three exploitation area at different depth.

Another important aspect is the extension of the underwater site, in fact, in order to avoid looting and assure a higher level of safety it should be a convenient choose not very large area or, alternatively, narrow it down in relation to the safety and surveillance systems that are available in the specific site.

The following list summarises the prerequisites that should be satisfied for creating underwater museums for the exploitation of archaeological remains (shipwrecks, ancient settlements, harbors):

- relatively shallow depth, usually up to 40 meters for recreational diving, with a maximum of 90 meters for technical scuba-divers;
- choose locations where there is easy access from the point of departure and arrival;

- choose locations where ordinary weather conditions are favorable for diving throughout the whole year;
- choose locations with clear water, without particularly hazardous conditions of currents and/or navigation;
- choose locations easily retained by normal visual means;
- choose locations where there is a sufficient number of reachable ancient remains that can be visited.

3.3 Underwater museums

The experience provided by the underwater museums to its visitors should not be limited to diving activity but start since as early as the visitor is involved in the briefing phase. In fact, most of the time, during the dive briefing, the visitor' expectations are focused on going into the water immediately, receiving a brief explanation of what to and not to do from the professionals, without considering multiple facts involved in the dive. In order to make them aware that there is additional valuable information to keep in mind it is fundamental to enhance their engagement by providing them adequate information and educational material in the form of traditional printed material and also by means of different paper-based communication languages, for example, with video, 3D printed replica of the submerged site, and also interactive virtual experiences that can allow visitor to better understand and keep in mind the dive plan and the points of interest. An efficient dive briefing help visitors to have a happier, safer, stress-free and more enjoyable experience in the underwater environment.

Then the experience continues in the underwater environment by means of PVC products with contents printed on them and also by means of innovative and more stimulating and attractive products such as the underwater tablet and the augmented diving system. When the visitors end the dive and exit from the water the visitor engagement continues by providing them instruments to remember their dive in the underwater museum and share

their experience. To this end the augmented diving systems allow users to take geolocated pictures that can be uploaded to the most popular social networks.

3.4 KACs

All those underwater sites that, as above mentioned in section 3.2, cannot be exploited because of the adverse environmental and weather conditions or legislative restrictions, it is possible to provide to the visitors an immersive virtual experience by means of the KACs. The KACs, in fact, allow visitors to live a virtual experience and explore the 3D reconstruction of the real underwater archaeological site overcoming all the limits imposed by the real environment.

The design of a visitor experience outside of the wet environment offers significant advantages not only to the underwater sites that are inaccessible to the large public but also to those in which an underwater museum has been established. In fact, the virtual experience provided by the KACs is not limited to entertain users but has a pedagogical value too. An interactice exploration of the virtual underwater sites can stimulate and improve awareness of the visitors by providing additional information about the historical, biological, archaeological context.

To this end, in order to enhance the engagement of the visitors outside to the underwater environment, the design of the visitor experience plays a fundamental role. In fact, while process information and video demonstrations on screen are still limited in interactivity and may not engage or excite visitors, it may be an efficient way to satisfy the curiosity of many visitors and perhaps inspire them to learn more by means of the KACs.

In particular, the KACs should present the following main features in order to provide an efficient experience to its visitors:

- rich information;
- interactive information;
- easy to use.

3.4.1 Rich information

A well knows issue related to visitor experience in a museum context is the “hard time” spent by visitors deciding which works to see or where to go next. To this end, KAC systems should not be overly prescriptive, but, on the contrary, provide recommendations that the user can use or ignore as he/she chooses. A fast and simple way to provide recommendations tailored on the user is the personalization capability of the KAC system that can be implemented through a fixed list of profiles (e.g. “Student” or “Diver”) from which visitors can choose at the beginning of their visit. But, as demonstrated by studies about visitors’ profiling preferences (Tan et al., 2006), a predefined categorization of visitors should be avoided because they prefer to have some direct control over their experience and are not satisfied with choosing a profile. Then it is important to provide to the visitors different and various information which can be accessed by visitors with different manners. In fact, having a variety of information, and ways to interact with that information, introduces a sense of freedom and potential that will spark the curiosity of visitors and lead them to consider not only whether they like or dislike an artifact, but also its connections to other artifacts or knowledge domains and, particularly, how it relates to themselves (Templeton, 2011).

3.4.2 Interactive

The interactivity is one of the key factors that influences the experience offered to the visitors, and in particular, it is strictly related to the engagement. In its broadest sense, “engagement” may refer to the degree to which visitors interact on any level with a museum and its content.

Interactive information enables visitors to make choices and to explore exhibitions and related content on their own, as far as they would like to go. Providing visitors more control in how they choose to learn about the exhibitions and individual works may help them to discover their own connections to the exhibitions. Interactive information frameworks may provide flexibility, customization, and incidental exploration. These behaviors are important

in transforming passive museum visitors into active information seekers and engaged visitors. Furthermore, interactive exhibits involve multiple senses that are generally accepted as very engaging, educational, and memorable.

3.4.3 Easy to use

KAC systems must be intuitive for first-time users to avoid frustration and distraction from the exhibition, should use familiar user interface (UI) design patterns and encourage exploration. An easy-to-use UI enables visitors to decide which information they find the most compelling and to easily make selections. On the contrary, for those UIs that are not intuitive and not well designed in according to a user centered design approach, the experience can get frustrating for the user and cannot access to the cognitive and emotional spheres of the visitors.

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