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## TECHNOLOGICAL ARTIFICES: GOOD PRACTICES FOR INCLUSIVE COMMUNICATION IN MUSEUMS

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**ABSTRACT** This chapter presents the wide variety of technologies and their applications in museums of different type, including archaeological ones. With their potentialities and constraints, the discussed technologies – from Virtual Reality to interactive systems – offer a range of uses and approaches that aim to be inclusive. Technological solutions can create new narrative environments engaging publics and non-publics in ways that are more innovative and immersive. New communication strategies correspond to the needs of various visitors without labelling them. Combinations of different communication devices can help transform the museum experience, creating connections between people and cultural heritage, and enhancing them at an emotional level. Since technologies are constantly evolving, this programme will require continuous updates and further developments.

**KEYWORDS:** accessibility; cultural heritage; technology; museum public

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## **Introduction**

One fundamental objective in contemporary management of cultural heritage in general and museums in particular is to further the study and appreciation of heritage. In terms of realization and access to content, this task requires increased attention to the plurality of publics and “non-publics” with specific needs. With regard to accessibility to cultural heritage, the Authors conducted a survey focused on accessing cultural content and addressing different audiences. In result, it emerged that museums usually focus on educational activities and support devices dedicated to audiences with specific needs rather than create integrated solutions “usable by all people, to the greatest extent possible.”<sup>1</sup>

While conducting the survey on the accessibility of archaeological heritage at museums and sites in Europe and worldwide, several aspects and perspectives have been considered: display solutions, communication devices, and modalities of mediation and interpretation of specific heritage that is sometimes difficult to communicate to less experienced visitors, also because of its often fragmented and decontextualised appearance. The use of technological solutions and communication devices could therefore support and improve communication, mediation and interpretation of archaeological heritage in an inclusive way. Current solutions no longer respond to the needs of specific audience categories such as people with visual impairment, for instance. However, it is possible to embrace many different audiences by combining several technologies. In this respect, the Faro Convention recommends the development and “use of digital technology to enhance access to cultural heritage and the benefits which derive from it.” It also highlights certain critical issues such as the quality of content, the protection of linguistic and cultural diversity, and the removal of “obstacles to access to information relating to cultural heritage, particularly for educational purposes.”<sup>2</sup>

## **2. Technological solutions and their applications**

In the last decades, digital technologies for museum use and communication have played a substantial role. In order to implement and improve communication strategies, as well as to reach new audiences and make accessibility and participation more inclusive, most museums have adopted innovative technologies. Museums are thus becoming increasingly connected, participatory and virtual.

Today, digital technologies foster and enhance communication in museums, both externally and internally. On the one hand, websites and social networks have streamlined online communication, encouraging and supporting the promotion of the museum’s identity and image as an institution. On the other hand, storytelling devices, multimedia, personalisation, and edutainment have strengthened on-site communication, promoting exhibited heritage, facilitating understanding, and encouraging active participation of visitors.

Although they do so in different ways, these technological solutions help to transform the

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1 United Nations, 2006.

2 Council of Europe, 2005.

museum experience from static and contemplative to more dynamic and customised. Moreover, by modifying the production of content, technologies can provide multi-layered information, expanding the cultural offer to satisfy the needs of different audiences.

There are plenty of digital solutions created for this purpose: they are presented in the form of a map (fig. 1), which aims to provide a comprehensive overview (though not exhaustive) of technologies available to museums. The map is continuously updated yet tries to represent primary digital modalities according to devices, applications, and the possible connections and relations they can form. This classification, which is not static but dynamic (like technologies themselves), is in a constant state of flux due to modernisation, improvement of available solutions and the development of hardware and software.

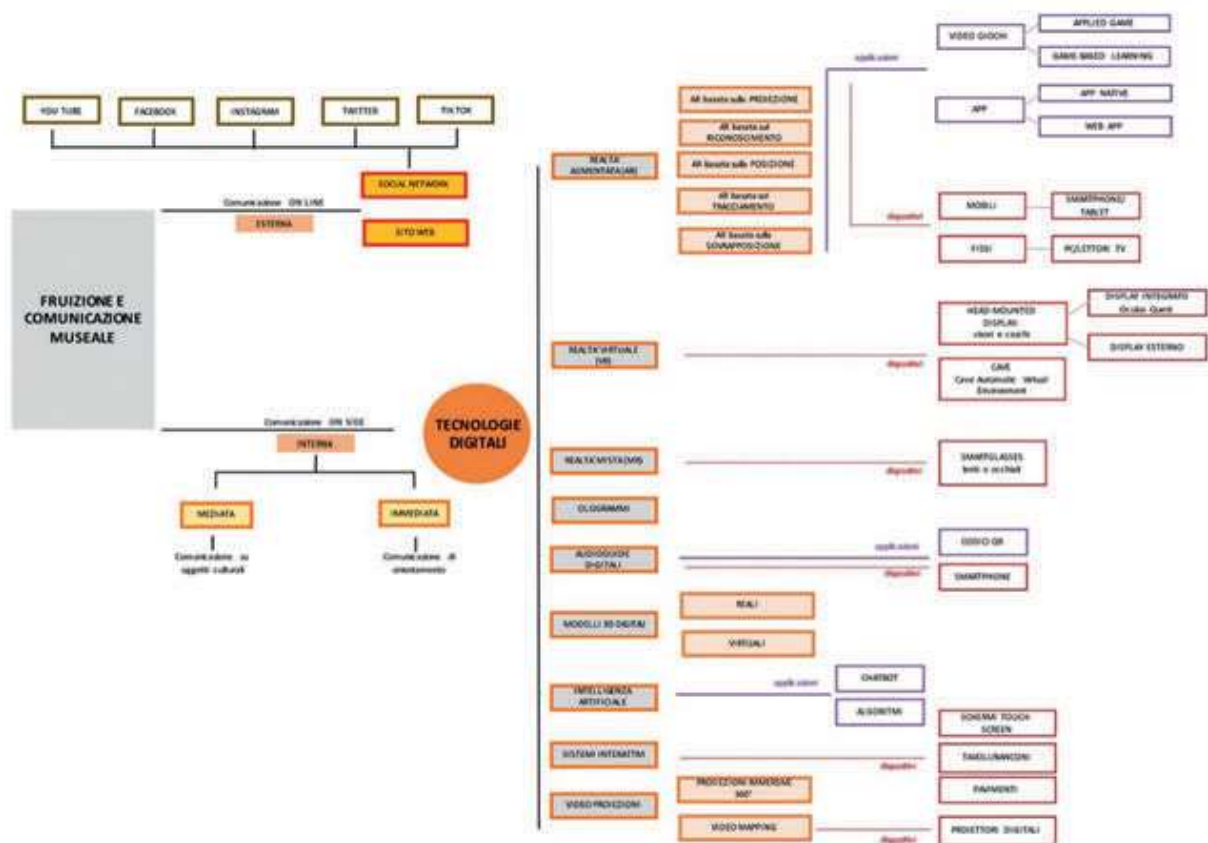


Fig. 1. Typologies of technological solutions for communication in museums (Cristina Boido).

Today, the technologies most often used by museums to enhance their exhibitions are: Augmented Reality (AR), Virtual Reality (VR) and Mixed Reality (MR). These solutions are particularly suitable for accessible and inclusive museum use by allowing for high levels of involvement and sensory immersion. Augmented reality is capable of superimposing the digital world on the real one, thus augmenting the perception of the latter and enhancing the experience thanks to virtual elements. Technology adds digital layers to the surrounding environment and enriches it with new content and stimuli. Thanks to smartphones and tablets, PCs and TV screens, visitors can take advantage of augmented reality, which enhances the museum environment, adding digital detail and bringing forth new layers. Augmented reality and material reality become a single

dimension with infinite possibilities and applications while keeping the real world at the centre. AR is undoubtedly the fastest growing technology of this type. It is implemented in many museums and archaeological sites thanks to its ease of use. For example, it can virtually reconstruct buildings that are now partially or totally destroyed, bring extinct animals back to life<sup>3</sup>, recreate ancient battles, or digitally restore precious paintings (fig. 2). Together with narrative techniques, AR can also bring heritage sites and events to life rationally and emotionally during tours.<sup>4</sup> Last but not least, among the applications of AR in museums we find video games<sup>5</sup>, which can stimulate the public, especially children and adolescents, and incentivize them to learn about culture.<sup>6</sup>



Fig. 2. Archaeological Park of Carnuntum (left), MuSe of Trento (right).

On the other hand, Virtual Reality is capable of creating a new digital environment modelled at will. It is entirely immersive and tricks the senses into thinking that one is in a parallel world. A three-dimensional construction or reconstruction of a real or imaginary environment that replaces physical reality, the simulation aims at complete immersion of users who find themselves transported into another dimension, where the real is replaced with the artificial.

VR requires head-mounted displays such as visors or helmets capable of making users experience the digital reality (fig. 3, left). In addition to visors, greater involvement can be achieved with gloves, earphones and other devices that stimulate the senses and interact directly with VR. These additions increase the users' capabilities, enhancing the immersive experience. Through visors and 3D reconstructions, surprising journeys can be made. At the Virtual Archaeological Museum (MAV) in Ercolano, visitors can explore domus and temples in the streets of Pompeii

3 Since 2018, the MuSe of Trento rents smartphones to visitors. They come installed with the AR app Go!Muse, which complete skeletons of some animals on display in the exhibition (most of them extinct) and make it possible to see them in motion as if they were alive, <https://www.muse.it/it/visita/servizi-museo/GOMuse/Pagine/GOMuse.aspx>

4 The Uffizi Gallery in Florence uses the AppTripper software for mobile devices, which allows museum visitors to create their itineraries basing on their personal emotional experiences.

5 The first museum videogame was "Father & Son" developed in 2017 by the Archaeological Museum of Naples (MANN).

6 Pacetti, 2018.

and Herculaneum just before the fatal eruption of Vesuvius in 79 (fig. 3, right); at M9 in Mestre, the audience can explore kitchens from the early twentieth century, then from the 1930s, 1950s and 1960s onwards using a joystick and even interacting with represented objects.



Fig. 3. People wearing VR visors in a museum (left), 3D reconstruction of a house in Pompei at MAV (right).

Mixed reality combines the real with the virtual, merging elements of both. It enriches the real environment with elements that are not physically present but where physical and digital objects coexist and interact in real-time. It offers the possibility of having one foot (or hand) in the real world and the other in an imaginary place, breaking down the boundary between reality and imagination, thus offering an experience that can change how space is perceived. MR can be considered an enhanced version of augmented reality, with certain differences: in augmented reality, interaction with reality is mediated with smartphone or tablet screens displaying the given object's features and functionalities.

With the help of smart glasses and other tools, MR allows information such as images, data, audio and video files to be shown on the display of the lenses. Visitors wearing special glasses can see



Fig. 4. Use of Mixed Reality at the Roman Archaeological Park in Brescia.

reality superimposed on a reconstruction of the past, accompanied with audio and video guide. An example of this is the solution implemented in the Roman archaeological park in Brescia<sup>7</sup> (fig. 4). This case proves how new technologies and targeted narrative techniques can play a crucial role in improving access to cultural heritage access and facilitating its appropriation. Holography is another effective tool for boosting learning through interaction and public engagement, especially when combined with narrative components and compelling animations. Although it is still scarcely used in museums due to high cost and complexity of implementation, three-dimensional images produced using this technique can replicate reality and produce fictitious representations thanks to optical illusion. Holograms can produce three-dimensional representations and animations of objects that were destroyed or lost, as well as archaeological findings, people, documents and other traces of the past<sup>8</sup> that are no longer visible (fig. 5).



Fig. 5. Holograms in museums.

High-definition projections have great communicative potential by offering three-dimensional representations visible without wearing special glasses. In addition, museums can use holograms to create specific animations to accompany and guide visitors in a more engaging and entertaining way.

Audio guides are certainly more traditional and much less expensive. These mobile devices allow visitors to enrich their knowledge of collections by simply typing codes on numeric keypads in order to obtain information about a given room or artwork they wish to learn more about.

Museums widely use audio guides because they are cheap, easy to use for most visitors, and often provide a multilingual mode. This technology, now almost obsolete, is increasingly replaced with multimedia audio guides or commonly used mobile devices such as smartphones. Scanning QR codes allows visitors to listen to audio commentary and access visual data.

<sup>7</sup> Visitors wearing AR glasses can see 3D reconstructions of sites with audio and video. This introduces spherical virtual reconstructions to the AR viewer, allowing the user to see today's reality with the reconstruction of the past superimposed on it. See: <https://www.youtube.com/watch?v=-165d7chLg0&t=50s>.

<sup>8</sup> The Moesgaard Museum in Aarhus also uses holograms to compare today's Aarhus with how the city could have looked in Viking times.

One example of this is the multimedia guide and app at the National Archaeological Museum of Madrid<sup>9</sup> (fig. 6, left). Both offer a general tour of the museum, including audio commentary, images and videos with subtitles. They also suggest specific itineraries for people with visual impairments and link to videos with information in sign language. While traditional audio guides allow the user to listen to information and stories, new multimedia devices allow for much greater interaction, supporting and engaging different audiences that range from the youngest to the disabled.



Fig. 6. Audio guide from MAN Madrid (left), use of 3D digital models in an archaeological museum (right).

In recent years, to improve the accessibility of their collections, many museums have adopted 3D digital models (fig. 6, right) that help with three-dimensional digitisation of exhibits. Thanks to the introduction of affordable and high-performance 3D printers, it has become possible to create accurate three-dimensional models of any size, achieving extremely high definition and realism.<sup>10</sup> These technologies have greatly supported museums, making it possible to display on-site and on-line replacement models of works that are too fragile or have been lost, thus guaranteeing wide accessibility for scholars and experts. For these reasons, museums that have adopted 3D tools to the greatest degree are archaeological museums, which use them to exhibit partial works as well as ones that have been destroyed or became fragile to light or atmospheric conditions.<sup>11</sup> In addition, these models are often used to offer tactile experiences to visitors, not only to the blind. Such a multisensory approach can improve the understanding of the objects on display.

Artificial intelligence will undoubtedly be the preferred technology for museums in the future. Today, we can encounter automatized systems such as chatbots, which are used as guides to

<sup>9</sup> <http://www.man.es/man/en/visita/guias-multimedia.html>

<sup>10</sup> Two famous examples are Michelangelo's David at the Italian Pavilion Expo 2021 Dubai, and the statue of "Persephone enthroned" at the Pergamon Museum in Berlin, reproduced in 3D at the Archaeological Museum in Taranto.

<sup>11</sup> La Veglia, 2019.



improve the visitors' experience, as is the case at the House Museum in Milan<sup>12</sup> (fig. 7, left). Through automated conversation in clear language, programs based on artificial intelligence can share information with visitors about works of art, making them curious and answering their questions. Furthermore, with the idea of bringing museums closer to people who are not used to visiting such places, this technology offers the possibility to ask any question without the fear of being judged.



Fig. 7. Use of a chatbot to guide visitors at the House Museum, Milan (left); AI application for comparative work in the collection of National Museum of Oslo (right).

Another application is already used in some museums that have embraced artificial intelligence algorithms. Offering the possibility to carry out in-depth studies of works on display, AI facilitates comparing specific elements such as decorations, techniques and colours. In result, it can create new and unexpected connections within individual collections and with the collections of other museums, as the National Museum of Oslo has recently done<sup>13</sup> (fig. 7, right).

Interactive systems are now well-established and present in many museums. They can be used by a single user at a time or collectively, helping visitors obtain in-depth information through audio-visual materials of various kind, suitable for audiences of different ages and cultural capital. Such installations make it possible to combine sense-motor learning (typical for interactive technologies) with symbolic-deductive learning (typical for visual tools). The most popular interactive systems are touchscreens, monitors as well as interactive tables, counters and floors. They engage visitors through animations and images that can change with body movements. For example, the Fondazione Querini Stampalia in Venice<sup>14</sup> installed large touchscreen walls that allow visitors to meet the characters from exhibited paintings, explaining their genesis and symbolic meaning. Touch tables can also be placed outside museums to reach and involve new audiences such as older people in nursing homes or children in hospitals (fig. 8, left).

<sup>12</sup> <https://casemuseo.it/chat-game-nelle-case-museo/>

<sup>13</sup> <http://vy.nasjonalmuseet.no/>

<sup>14</sup> Testino, 2015.



Fig. 8. Touchscreen tables in a nursing home in the Netherlands (left); video projections on an interactive book at the National Museum in Zurich (right).

Finally, new technologies include 360° and video mapping projections. Such immersive solutions are rapidly evolving and accustoming people to enjoy digital content in public spaces and buildings. These projection systems are suitable for collective appreciation in different environments: on surfaces that are not necessarily flat (often being circular, spherical or cubical) or on existing and newly created three-dimensional objects. These technologies make it possible to transform any surface into a dynamic display, creating highly involving and immersive effects for the spectator. A good example is one of the four interactive books in the National Museum in Zurich (fig. 8, right), which allows visitors to explore the nation's stories and events.

## **Conclusions**

Devices presented here contribute to the creation of new “narrative museum environments,” where everyone has the opportunity to learn something by becoming involved in innovative and varied experiences that put cultural heritage in a different perspective. Nevertheless, technology should remain only a means for improving and completing the visitors' experience. It is a resource that can be used and enhanced to make culture more inclusive, creating increasingly personalised, interactive and educational experiences. Furthermore, thanks to such solutions, it is possible to design new communication strategies that are more adapted to the needs of different audiences, including and reaching as many visitors as possible without necessarily having to create new tools and categorising media. Therefore, choosing the types and methods of these digital devices requires much attention to the audience and to the relationship between technology and the museum environment. Digital solutions must be integrated into the exhibition and not just added to fill gaps concerning accessibility, for example to support audiences with disabilities or children.

The recent Covid-19 crisis has generally accelerated the use of digital technology and communication in the cultural sector, creating new forms of access to museums and cultural venues. Although the health crisis has undoubtedly shown how relevant and fragile the link between cultural heritage and people is, thanks to digital technologies many cultural institutions

have been able to stay in touch with their audiences, although not always in a planned and strategic way. On the one hand, digitisation has facilitated remote access to museum environments and contents. On the other, it has offered the possibility to explore museum collections in new, immersive and interactive ways, not only to amuse and entertain visitors but also to offer them alternative methods of accessing content and cultural appropriation. Technologies can indeed support cultural experiences in different ways. Even if digital content cannot replace physical visits, it can potentially be used for many purposes such as enhancing visitors' experiences by making them more interactive, inclusive and helpful for in-depth analysis. As the above examples illustrate, the most original and effective results are often obtained by using a combination of different technologies or by supplementing them with narrative techniques and communication tools. For example, the use of storytelling along with immersive technologies such as augmented reality can breathe new life into places and events from the past, enhancing the experience not only in rational but also in emotional terms.

Although the variety and potential of technologies made it possible for a growing number of people to access museum content, their use does not always help to achieve the goal of including and engaging (also emotionally) different audiences. There is risk that it may become a barrier between people and museums (UNESCO, 2015). Therefore, it is necessary to calibrate their use precisely and consciously. Moreover, both the hardware and the software of these digital media are constantly evolving. It is therefore essential to design museum projects not only in terms of physical space but also digital one in an integrated way. Since many technologies are costly, maintenance represents a continuous challenge since they change and evolve fast, with the risk of becoming obsolete quickly as well as difficult and expensive to service. Therefore, it is vital to understand the return value of their use basing on set objectives and the level of appreciation among visitors.

As the Network of European Museum Organisations reported in 2020 regarding motivations for the application and use of new technologies in museums, central answers are related to the audience: "to attract more online visitors, to diversify museum audiences and to increase the relevance of content creation and mediation."<sup>15</sup> Therefore, future challenges will involve wisely calibrating the methods and forms offered by the most innovative digital technologies to communicate, promote and enhance culture heritage in the best possible way, making it more inclusive and accessible for all.

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15 <https://www.ne-mo.org/news/article/nemo/survey-on-new-technologies-and-innovations-in-museums.html>

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