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DIGITAL VISUALIZATION AND MULTIMEDIA FOR CULTURAL HERITAGE ACCESSIBILITY: DESIGNING "FOR ALL" VIDEO-TOURS AT THE ARCHAEOLOGICAL NATIONAL MUSEUM OF NAPLES (MANN)

Alessandra Pagliano, Barbara Ansaldi**

*University of Naples "Federico II" – Naples, Italy.

Abstract

In recent years, drawing disciplines supported by digital technologies have played a fundamental role in the interdisciplinary approach to communication. Digital media and ICT in general are a versatile means of managing and customizing communication at different levels according to the user's personal needs. The paper presents the output of a recent research funded by the Archaeological National Museum of Naples (MANN), which aimed at designing four video-tours, each customized according to the different needs and functioning of a large, diversified target audience, also including users with Autism Spectrum Disorder (ASD) by exploiting the potential of Virtual Reality.

Keywords

Design for all, accessibility, inclusion, autism friendly, archaeology, digital illustration, digital animation,

1. Digital media for accessibility: filling the gaps in cultural heritage fruition

The possibility to fully enjoy cultural heritage is a freedom and, therefore, a fundamental right of all human beings, as stated in the *International Human Rights*' core principles. Moreover, the *Convention on the Rights of Persons with Disabilities* (CRPD), which was approved in 2008 by the United Nations, enshrines the right of all individuals to participate in the cultural life of the community on equal terms, through the support of appropriate measures that ensure the access to cultural heritage of any kind and nature.

The legislative Dec. No. 42 of January 22, 2004, better known as the *Cultural Heritage and Landscape Law Code,* states that promoting a better knowledge of cultural heritage as well as ensuring the best conditions for its full enjoyment "for all" are central actions for the enhancement of cultural sites, which are therefore called to provide, as a necessary and obligatory action of their mission, adequate levels of accessibility, both physical and/or perceptual-cognitive, in order to meet the needs and requirements – whether expressed, implied or special – of a wide range of audiences.

Designing for accessibility means putting human beings and their peculiarities and needs – whether temporary or permanent – at the center of attention, without designing for a so-called standard that is no longer recognized. From this perspective, DIS-ability, diversity or "NON-neurotypicality" have become obsolete definitions, since the very definition of a standard of normality is now being outdated.

The issue of accessibility and full enjoyment of cultural heritage concerns all individuals: in the light of the new definition of disability introduced by the World Health Organization in 2001 (World Health Organization, 2001), every person over the course of his or her lifetime, may experience situations that cause him or her to have conditions of limited ability, whether physical, mental, intellectual, or sensory.

The information provided by ICF is a description of circumstances concerning "human functioning" and its possible restrictions, instead of considering permanent conditions. A person's functioning is conceived as a dynamic interaction between health conditions (diseases, disorders, injuries, trauma, etc.) and contextual factors, where the latter include both personal and environmental elements (Attaianese & Minucci, 2019).

It follows that the user may have a certain functioning (resulting from health conditions and/or socio/cultural factors) with respect to a given context that prevents him or her from enjoying a cultural asset: functioning thus determines a need for appropriate solutions, that is precisely what the Design for All approach focuses on (Tosi, 2017).

Inclusive design puts real people with their variability, diversity, and autonomy at the center.

The topic of inclusive design in recent decades is frequently integrated with the one of digital technologies applied to user experience. If designed and subsequently developed according to inclusiveness principles, ICT can be highly effective, innovative tools for the enhancement of human abilities. ICT can indeed overcome barriers (both physical and cognitive) and make culture accessible by an increasingly large and global audience, contributing to a real valorization of Cultural Heritage, and, consequently, to the improvement of society. ICT may be a versatile means of managing communication at different levels according to the user's personal needs (Brischetto, 2017).

Historical sites and museums are progressively embracing different methods to share and convey cultural heritage, employing digital technologies to craft fresh stories to create fully accessible cultural contents. The benefits of digital visualization and multimedia for cultural dissemination range from cultural and physical accessibility to interpretation, engagement, and communication.

In recent years, drawing disciplines supported by digital technologies, have been playing a fundamental role in the interdisciplinary approach to communication of cultural heritage.

2. Tailored and accessible cultural contents for MANN's permanent collections

The enormous holdings of the National Archaeological Museum of Naples (MANN) are impossible to visit in a single day. The applied research project, entitled *The Masterpieces of MANN*[1], created No. 4 video-guided tours, according to a transversal path across the museum's different permanent collections, bringing the user into contact with a certain number of "masterpieces" capable of conveying, in a single visit, an awareness of the richness of the museum's holdings through the experience of a selected sample of assets. In-person enjoyment in the museum of carefully selected works is assisted by short videos that, through a combination of digital graphics and illustration, photography, renderings, animation, sound, and storytelling, provide captivating explanations with a storytelling tailored on specific needs, in order to meet the needs of the largest audience possible (Falchetti et al., 2020). In this way, it is possible to grant access to cultural content and enjoyment of beauty also to audiences which are characterized by different functioning, needs and expectations during the museum visit. It was no longer a matter of finding solutions to eliminate a barrier (in its broadest sense and thus, both physical and intangible in the cognitive sense); instead, the idea was to rethink the very basis of the project of communicating knowledge and enhancing the value of cultural heritage, considering the needs of "real" people as starting elements.

In this perspective, there are no "special" solutions for "special" users, but every intervention should be designed and developed considering the needs of as many people as possible, since designing for those in disadvantaged situations can only have a positive impact on individuals in normal psychophysical conditions as well. The experiential requirements of users were thus the starting point to develop the storytelling of each artwork and to choose the digital technologies and techniques to be adopted accordingly.

Thus, the first step in our design was to define our target-audiences, dividing it by age into three categories with very different behaviors, needs and expectations during the museum visit: adult, teen, and child. However, such categories of visitors could have generated a negative impact on those users who might not have recognized themselves in one of them or disliked being identified under that specific label.

Hence, starting from these three broad groups of museum users, we analyzed the specific behaviors of each rather than its characteristics, in order to identify expectations and needs, with reference to prior experiences that affect learning.

[1] *The Masterpieces of MANN* is a two-year convention for applied research, recently concluded in July 2023, carried out by the Department of Architecture of the University of Naples Federico II and commissioned by MANN, with prof. Alessandra Pagliano being the scientific leader.

The three video tours have been titled with augmentative suffixes (fig. 1) since each one of them aims at increasing the enjoyment of archaeological heritage during the in-person museum visit. Perin states that if a museum is good for children, it is good for everyone (Perin, 2017): accordingly, we set out to redesign all the paths starting from this shared awareness. Analysis of children's functioning, needs and interactions in museums (Filova, 2019) showed that the public engagement of young users is achieved by designing an experience capable of generating empathy.

Knowledge is thus to be conveyed via emotions and through fun and game, since the value of cultural heritage can't be recognized exclusively through information and aesthetic appreciation, as in the case of adult audiences already trained in the museum enjoyment.

Designing children-friendly divulgation of cultural heritage content, therefore, means relying on how their experiential universe works, that is, on what makes them responsive and aware of the context. Thus, our videos have been designed to stimulate informal learning experiences at MANN in a playful way. The purpose is not only to convey cultural content but also to promote education of museum fruition and enjoyment through curiosity, which is stimulated by the child's feeling of being able to detect, in the videos, those artistic details of the asset that build its value and identity.

By conveying curiosity on visual aspects, details, shapes, and colors, and engaging children' interaction through direct and friendly language, knowledge can be gained through an experiential learning, which is further increased by entertaining them through the guiding characters' actions. This is a more effective way to acquire information and to remember the experience with enthusiasm rather than boredom, thus increasing awareness of cultural heritage.

In each video, we designed a child-friendly experience for visual learning in art museums through a playful design approach. The eight SuperMANN tour videos prompt the young visitor to notice visual details, understand their meaning, and relate to the overall artwork shape. This is meant to guide the audience in learning how to observe an artwork.

Fig. 1: Logo designs and specific features of the three different video tours: SuperMANN, GigaMANN and UltraMANN.

Two special characters have been designed for each video-tour, according to the preferences of the target audience; they have the role to interact with young users and guide them through the observation of each masterpiece.

For the SuperMANN video tour (Figg. 3-4), the main character is a friendly and positive hero that the child can identify with. To activate funny dynamics during the narrative, the second character is the famous "Munaciello"[2] of the Neapolitan tradition, who constantly performs small, naughty and, at the same time, funny mischief, which it will be up to SuperMANN to stop.

[2] *Munaciello* is a legendary spirit of Neapolitan folklore, both beneficent and mischievous. He is usually depicted as a deformed little boy or a person of short stature, dressed in a habit and silver buckles on his shoes. In our videos, he is the antagonist of the positive hero. In each video, the Munaciello always commits naughtiness, which, however, cannot be classified as evil actions, as indeed happens to many children.

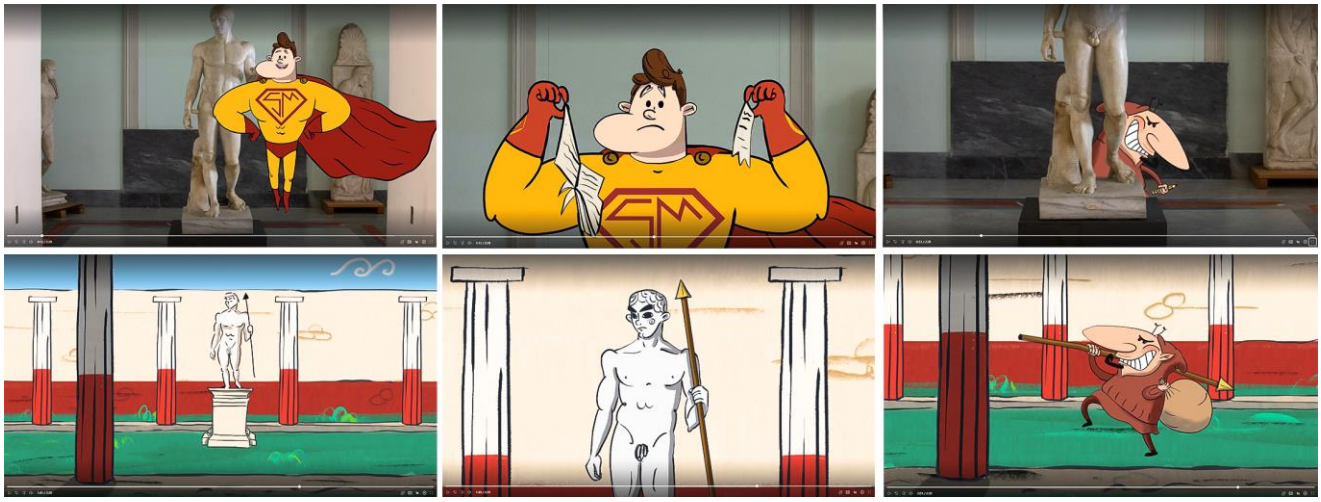

Fig. 2: Some screenshots from the episode dedicated to the Doryphoros in the SuperMANN video tour, by Federica Crispo.

3. Designing accessibility for an autism-friendly video-tour

With the aim of expanding the target audience as much as possible to ensure accessibility to the broadest audience, the design of the SuperMANN path also considered children with special needs, that is young visitors who were born with cognitive impairment, psychiatric problems, learning disorders or development delays. One of the goals of the research is to explore the possibility to apply Universal Design as a learning method to design exhibitions for children (Fig. 4).

According to the director Giulierini: «the new museum is expected to play an ethical role and be active in the construction of an educational, cultural and economic strategy within the city» (Giulierini, 2021, p. 21).

In the last twenty-five years, virtual reality (VR) has proven to be an effective tool for non-neurotypical people because it's a drawn space (Cobb, 2007) that can act as an experiential medium between subjects with ASD and real space, since they are not able to effectively and consciously adapt themselves to it, probably due to an altered sensory integration which determines an alteration of cognitive processes (such as concentration, planning, attention).

VR digital space can be drawn to provide gradual perceptual stimulations: visual details can appear step by step, providing essential information about the environment according to a designed orderly sequence, in order to minimize sensorial overload and to avoid distraction (Pecora, Attaianese & Pagliano, 2021). Since people with ASD are usually accompanied on cultural visits by an individual guide, specifically dedicated to them, a character (strongly marked by a colored details) has been designed, drawn in digital illustration, animated and voiced, to catch their attention.

Fig. 3: SuperMANN and the Munaciello, guiding characters in SuperMANN video-tour, by Federica

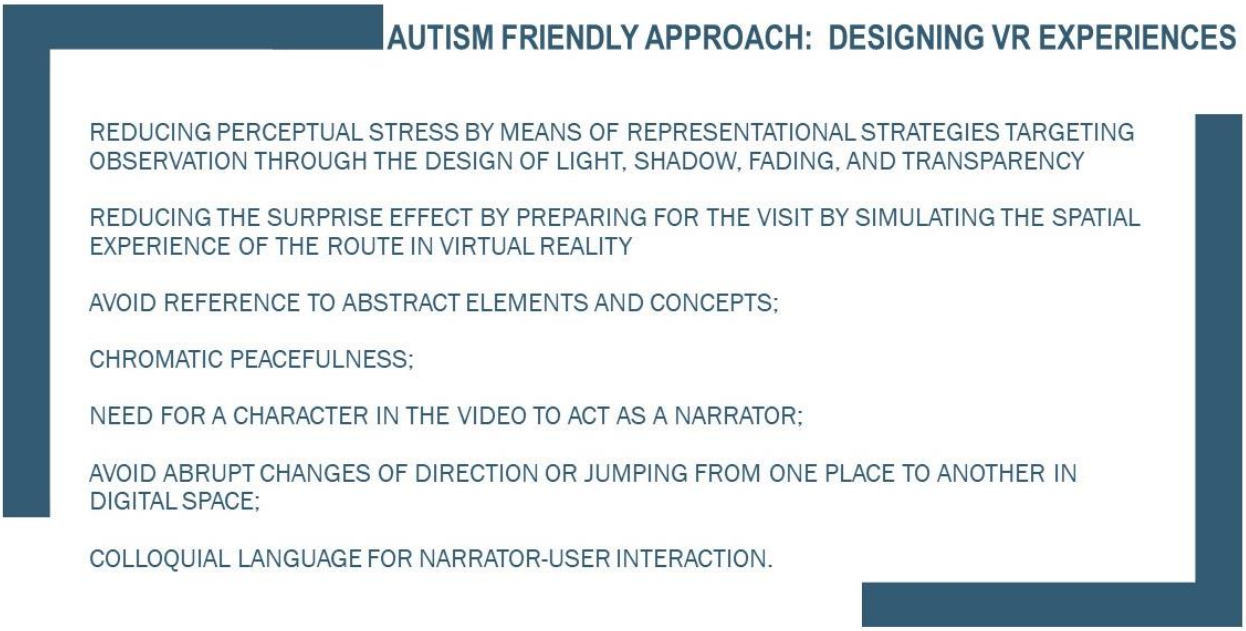

Fig. 4: The main criteria of autism-friendly design in VR experiences.

This digital character has the role to become a visual target (fig. 5), to support the narration by interacting with the user with a conversational and familiar language, and to drive the attention on specific details in the VR scene. To support the narrative, the digital guide, our character, makes use of whiteboards, tablets, or other printed media that reenact the dynamics of the traditional in-person visit in which specialized associations use drawings, photos, and graphics to visually support the storytelling, helping the user to understand and memorize more complex concepts (Pecora, 2023).

For the Pompeian frescoes found in the so-called House of Jason, the guiding character is drawn as a fascinating Aphrodite, goddess of love, who will guide the visitor in the enjoyment of the images and stories depicted in the frescoes whose

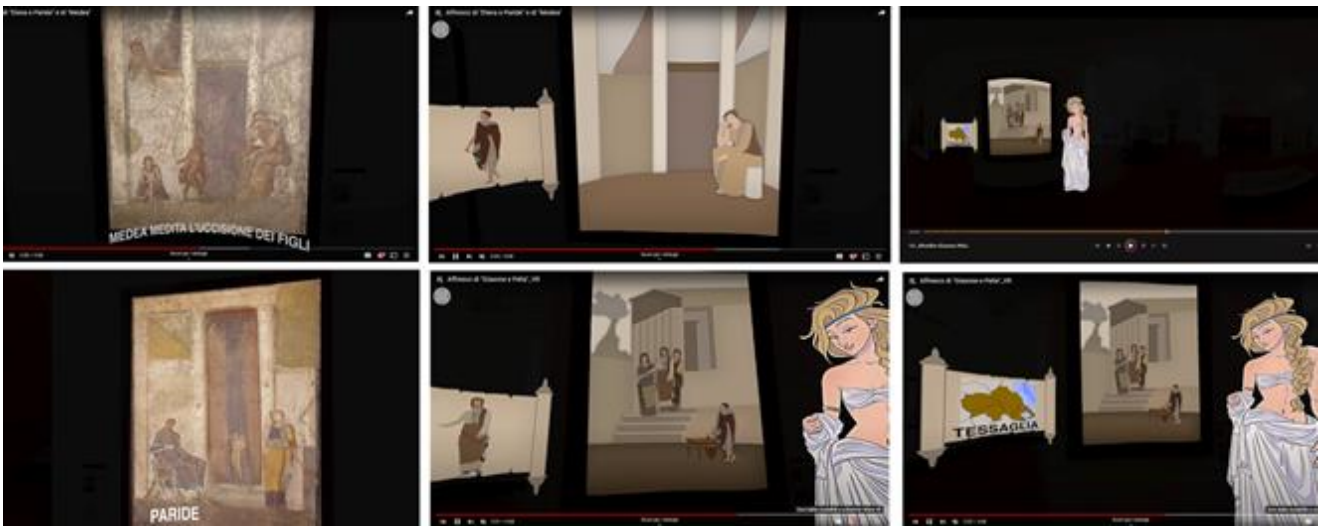

Fig. 5: Some screenshots from the VR autism-friendly video tour, by Daniele De Pascale.

Fig. 6: Narrative sequence to tell the story of Europa on the bull, drawings by D. De Pascale.

main theme is that of mistaken loves that have in Greek and Roman mythology caused several unhappiness and drama (Fig. 7). Due to passage of centuries, the frescoes' colours are all very faded: although the scene is still recognizable, a kind of chromatic uniformity due to the "patina of time" makes it difficult to enjoy the details, which tend to blend with the backgrounds without a color contrast. Consequently, the representation strategy aimed to detach the visitor's perception from the surrounding context, which is richly decorated and highly stimulating in terms of spatiality, light, and color.

This disengagement was achieved by concentrating the light only on the chosen visual target, while also giving the viewer the opportunity to see the rest of the virtual 360-degree space in penumbra. This leads the viewer to notice first and foremost the fresco depicting Jason and Pelias that is located on the entrance wall of the exhibition hall dedicated to the cycle of frescoes.

The painted scene was also shown with a logically ordered sequence of appearances: characters, details, and planes of depth, appear in correspondence with their own description so as to isolate the focus on each character, his or her clothing and appearance (Fig.6). Each video has been tested at the museum by the social cooperative "Il Tulipano art friendly": the effectiveness of the immersive narration produced an excellent result in terms of perceptive overload reduction, in terms of memorization and in terms of ability in recognition of details and characters that had previously been observed in the VR video.

Fig.7: The logo and the QR code to access the playlist of the VR video-tour designed according to an autism-friendly approach.

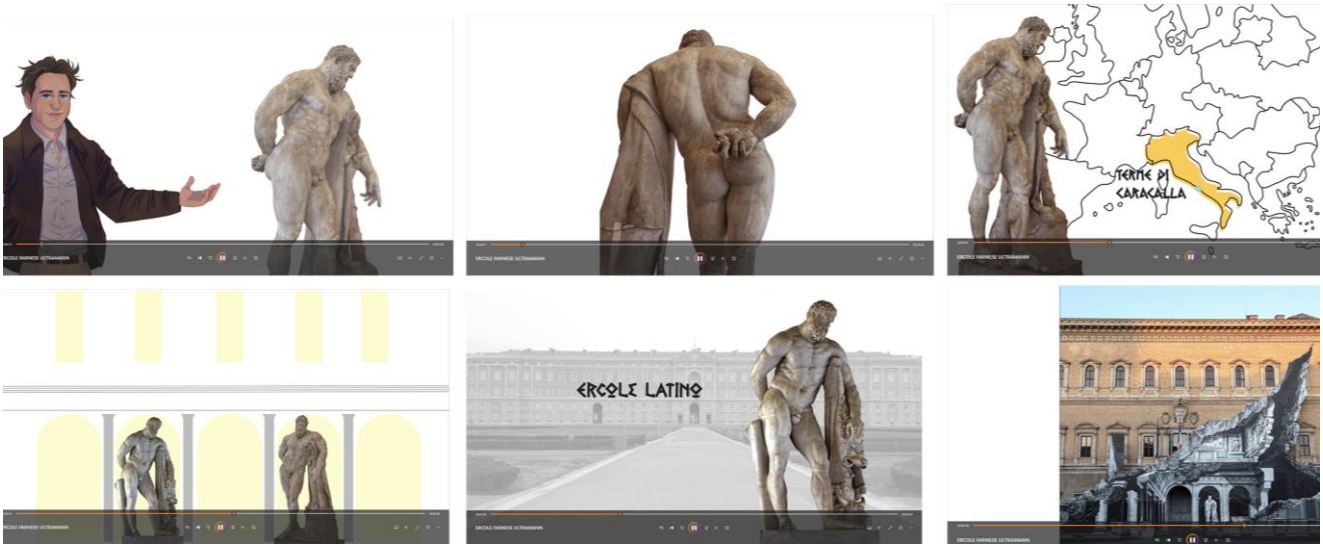

Fig. 8: Some screenshots from the UltraMANN video tour, by Carolina Spiezia.

4. Tailored learning paths for the same visit tour: increasing families' experience at the museum

Recent studies related to the issue of young people and children visiting museums demonstrated the need for encouraging family visits, since in Italy the approach of young people to cultural heritage is left exclusively to schools (Iasevoli, 2008).

In order to design an in-person visit to the museum that could engage both adults and children with the support of customized narrative strategies for the best transmission of cultural contents, we had to focus on the specific needs of these two audiences, with the aim of creating a circularity between them. The different approaches to the same path were designed to be clearly perceptible thus generating interest, curiosity, and a desire to activate an exchange of content and experience, eventually left to the spontaneous interaction of each family group. The path dedicated to adults, titled UltraMANN[3] (Fig. 8), creates connections and prompts memory recall of audience's previous experiences of travel and museum visits, creating relationships between distant places and emphasizing similarities or differences between artworks in the MANN and those belonging to European museum collections, in a sort of virtual journey between places, times and cultures. The UltraMANN tour has an off-

Fig. 9: Testing an alternative reconstructive hypothesis for the Doriforous, according to the original Greek bronze statue, by Marco Lucignano.

[3] Ultra [from lat. ultra] is a suffix with the meaning "beyond, beyond, more than"; it was chosen to connote the specific strategies of this video-tour that intends to relate the Mann's archaeological assets to those of other museums or places, such as those of the discovery of individual assets.

screen narrator (performed by Carolina Spiezia) and a single guiding character, voiced by museum director Paolo Giulierini.

5. Digital technologies for survey and representation

Digital technologies employed to calibrate representational strategies for the communication of cultural content become the glue between imagination and the real object. In fact, digital technologies are capable of immediately activating the comprehension process, generating user satisfaction and banishing the possible sense of frustration that comes from feeling inadequate to understand the cultural content.

Digital visualization solutions can also expand narrative potentials by representing objects, places and interaction that are not present in the physical space of the museum. Digital representations enable to visualize objects, places, reconstructive hypotheses, simulations, virtual environments, communicating complex information, concepts, and ideas in a more intuitive and accessible way (Fig. 9). Thus, we used numerous digital technologies, each depending on the data to be acquired and/or communicated.

For those related to the digital drawing and animation techniques, see the next section authored by Barbara Ansaldi.

Instead, this section describes the technologies adopted for surveying marble sculptural artworks, to be later transposed to videos. Due to the need to get a three-dimensional model of each sculpture with high-definition textures, marble statues have been surveyed by means of digital photogrammetry. Each statue has thus been digitized to obtain a three-dimensional object, which can be explored in full relief, even in positions that are physically inaccessible in the real space. Digital twins of the marble objects were the starting point for testing, analysis, and reconstructive hypotheses, while providing endless pictures and video sequences to be used for the subsequent valorization.

For summary reasons, we only describe the survey of the Farnese Atlas (Fig. 10), carried out by means of digital photogrammetry.

We used a total of 990 photographs taken with a Canon EOS 250D SLR camera (6000x3368 px), which is suitable for focusing on semi-reflective surfaces such as the Atlas marbles. The digital photogrammetry software used was *Agisoft Metashape Professional*. It was not possible to use a flash; two reflectors with semi-transparent white light diffusers had to be installed to increase the brightness of the room and the marble surface itself. The reflectors were positioned in advance to achieve the best balance between the softness of the light and the shadows cast on the marble surface. The reflectors' position remained unchanged throughout the entire photographic campaign. The mesh polygon number of the entire statue, later reduced to obtain a lighter model suitable for dissemination, has 981,464 vertices and 1,918,026 faces, while the Globe alone (separate from the general model) has 186,007 vertices and 359,587 faces.

We paid the utmost attention to the processing of the ultra-high-resolution texture which maps the 3D model to obtain a perfect digital copy (Fig.

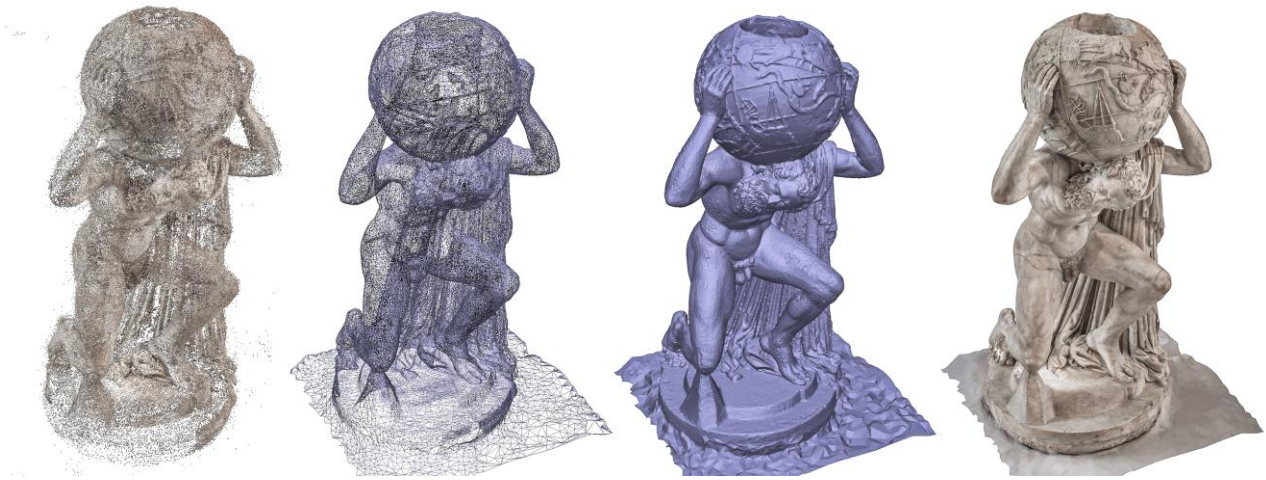

Fig. 10: Surveying process for the Farnese Atlas: digital 3D model from point cloud to the textured meshes, by Marco Lucignano.

10), not only in terms of geometry but also in terms of material-surface characteristics, which allowed us to query the 3D model obtained in search of the traces and signs of possible transformations over the centuries. This searching for traces, which strongly characterizes the analysis of works in archaeological terms, on a three-dimensional digital model is enriched by the possibility of verifying the hypotheses made in relation to the overall geometry of the forms, always relating each detail to the unicum of the object.

Figure 11 clearly shows the conical cut-out in the marble block, which has cancelled out Ursa Major and Ursa Minor constellations, as well as interrupting the bas-relief of the constellation Dragon in the circumpolar area. This detail is usually invisible for visitors because the marble statue is quite tall and the 3d model can offer to the museum visitors the possibility to observe the marble celestial sphere assuming, by means of a digital camera, an inaccessible point of view.

Fig. 11: Surveying process for the Farnese Atlas: digital 3d model from point cloud to the textured meshes, by Marco Lucignano.

6. The GigaMANN itinerary: 'narrating' MANN masterpieces to young visitors

In an age dominated by social media and video content, young audiences' attention has become harder to engage, especially when it comes to Cultural Heritage and museums. In fact, the GigaMANN itinerary was the most complex to plan and design, as finding the right, successful storytelling style was quite challenging. Among the possible communication strategies, digital storytelling has emerged as a powerful medium for museums to narrate their masterpieces, captivating a global and diversified audience. By blending technology and art, digital storytelling allows museums to transcend the boundaries of physical space, so that viewers can embark on immersive journeys through their collections, both on site and from the comfort of their homes (or classrooms). Through meticulously crafted digital narratives and interactive elements, digital storytelling breathes life into canvases, sculptures, and artifacts on display, offering a dynamic and engaging experience that goes beyond traditional static exhibits. It not only provides historical context but also invites viewers to explore emotions, ideas, and cultural significance behind each masterpiece, making art more accessible to diverse audiences.

This communication modality is particularly effective with younger audiences, who are inherently tech-savvy and often find it more engaging to interact with content through digital platforms and devices. Plus, given that young people have basically abandoned traditional broadcast media and looking almost exclusively to the internet as a source of information, "*entertainment and networking, museums will be obliged to invest heavily in their online presence, and will need to become increasingly sophisticated in their use of technology*" (Serota, 2009, p. 23). By bridging the generation gap between the traditional museum experience and the digital world, digital storytelling techniques can transform the 'contemplation experience' of viewing art into an interactive and dynamic journey. Conveying the story behind an artwork through such a language aligns with teenagers' familiarity with digital media, making the museum experience more relatable, accessible, and engaging, ultimately fostering a deeper appreciation for art and heritage among this age group. In particular, animated storytelling *"[...] is the most promising in terms of being able to narrate a story that points to the belly and the heart of the observer, traversing linguistic and cultural barriers [...]; it is in fact a powerful act of simplification which is light years ahead of the lectio magistralis ex cathedra that the traditional museum imparted,*

and which puts the public at ease by seducing them with the power of word, sound and image, both "educating and entertaining" according to the formula of edutainment" (Tanasi, 2022, pp. 11-12).

In order to tell the stories of some of the most iconic works of art housed in the MANN to a young audience, we chose to create a series of educational videos starring two main animated characters, ErMANNo and MANNuela (Fig. 12). As Joe Lambert, founder of the Center for Digital Storytelling, argues, *"animating a character within a background as a means to illustrate a story can be deeply satisfying for everyone […]; in the larger field of Digital Storytelling, the approach of linking professional animators with grassroots storytelling has been tried to great success*" (Lambert, 2018, p. 46). Digital storytelling videos based on animation are entertaining, educational, and engaging: digital media deepens the visitor experience, showing the museum's collections in an immersive, more relatable way. Moreover, the characters interact with viewers and narrate the artworks' stories by leveraging on an informal language and a sufficiently fast-paced rhythm to keep the attention alive throughout the videos. Parallels and reference to our present era as well as links to current topics/events, mixed with humor and sarcastic tones, proved to be the key to involve younger visitors and to connect with them.

6.1 Character Design

Character design is a branch of concept art, a term probably coined at Disney in the 1930s (Ghez, 2015) which refers to production artwork used in video games, movies, animation, TV shows and similar forms of visual entertainment to visualize and design environments, settings, characters, creatures, props, outfits and other elements that build the 'visual architecture' of a project. Character Design focuses on visualising and creating the look of individual characters as a means of conveying stories: therefore, every detail of a character, such as shapes, colour palettes, and details, must be carefully chosen, as the aesthetic qualities mirrors and communicate the character's personality and background.

After an exploratory phase based on researching, sketching and thumbnailing, the final design was presented through a model sheet, which might look very similar to an architectural project: the character is indeed represented according to its orthogonal projections, showing its front, side, and back views (Fig. 13). The design is accompanied by a series of additional representations that help conveying the characters attitude, such as facial expressions, gestures and poses. The leading characters designed for the GigaMANN itinerary had to respond to modern, appealing cartoon-style aesthetic, characterized by a teenage appearance and contemporary outfits mixed with classical Ancient Greek and Roman fashion.

We opted for creating both a male and a female

Fig. 12: Final designs for MANNuela and ErMANNo with their color palettes. Designs by Barbara Ansaldi.

character, whose Italian-ish names, ErMANNo and MANNuela, play on the acronym of the Museum (MANN). ErMANNo's attire recalls the colours of Roman warriors' armor (gold and red), while MANNuela's clothing is a contemporary interpretation of the typical garments of Ancient Greece, with a colour scheme based on white, blue, and gold. ErMANNo is introduced as a nineteen-year-old young man and a descendant of legendary Greek hero Hercules, a lineage which he is very proud of. His attitude reminds of the high school jock stereotype: athletic, good looking and full of himself but definitely not standing out for his brilliance. To underline the connection to the

legendary Greek hero of the Twelve Labors, he is depicted holding Hercules' mythological club. MANNuela is eighteen years old and is instead a descendant of the Titan Atlas, whom Zeus forced to carry the entire celestial vault on his shoulders.

different attires (Fig. 14), a range of facial expressions was also provided for both characters, as well as a set of recurring mouth positions to animate their speech (Fig. 13) through a frame-by-frame animation technique.

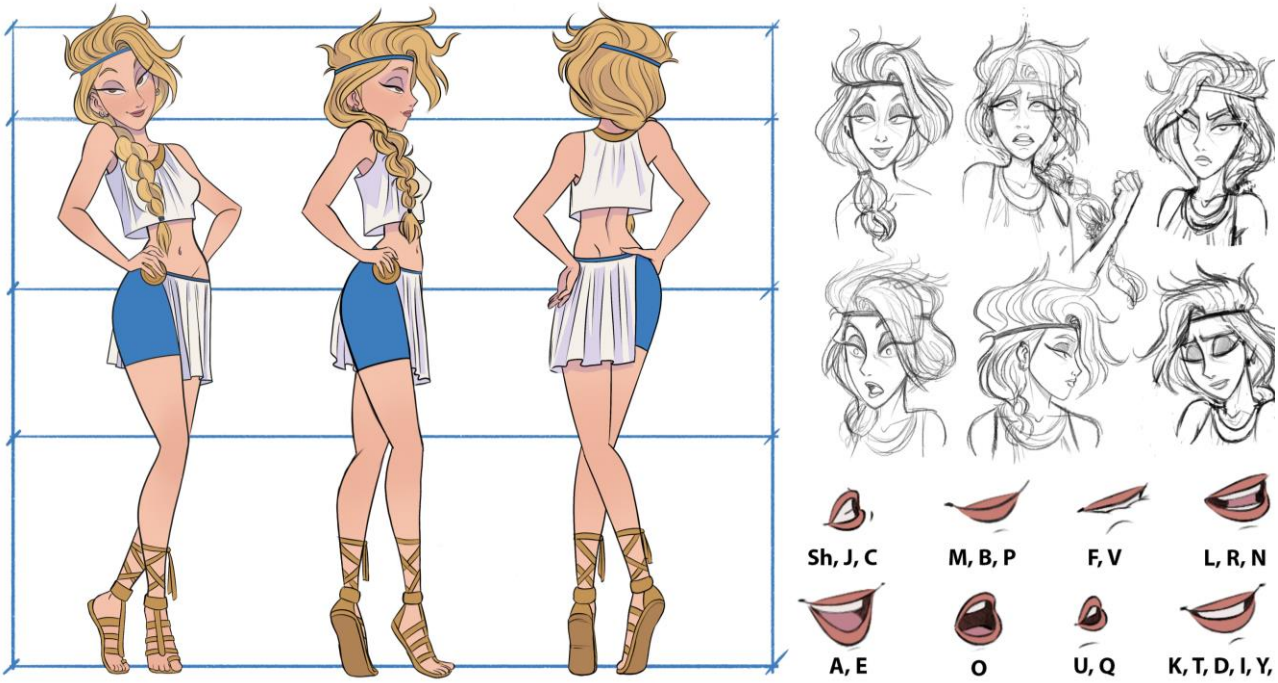

Fig. 13: Turnaround, facial expressions, and mouth positions for MANNuela. Drawings by Barbara Ansaldi.

MANNuela is the smart one, a well-read, confident, and patient young woman. She is passionate about fashion, astronomy, and astrology, but above all, she loves to wander around the MANN Museum and has a soft spot for classical statuary.

During the pre-production phase, in addition to the design of the characters' features and

6.2 Methodology

After defining the design of the main characters, each video was created by using a methodology which can be summarized in the following steps:

1) Scientific research;
2) Script and storyboard;

Fig. 14: Costume designs of ErMANNo and MANNuela' alternative outfits. Designed by Barbara Ansaldi.

3) Voice recording and editing;
4) Backgrounds, illustrations, frames, graphic elements;
5) 2D Animation;
6) Video Editing;
7) Music and Sounds.

Scientific research about the selected artworks was carried out by Greta Attademo and Angelo Triggianese and consisted in collecting and providing targeted information to write a script tailored on a young audience. Cognitive load, which is the information provided through visual/pictorial and auditory/verbal channels, had to be accurately calibrated. The script was written by turning the selected content into a captivating narration by ErMANNo and MANNuela. According to the personalization principle by Mayer (2008), all the scripts were written using a conversational style rather than formal, academic language, which has been shown to have a large effect on students' learning, as it promotes a sense of social connection with the narrators, which ultimately fosters a better engagement (Mayer, 2008). Indeed, one of the goals was to build and reveal the characters' personality traits - and the dynamics between them - through the videos themselves, so that, artwork by artwork, young viewers could bond with the characters and look forward to the next video to see further interaction.

Storyboarding is the 'visualization' of the script, which is graphically represented through a series of pictures and descriptions illustrating the key moments in the storytelling to get a visual sense of how the final video will look and unfold (Fig. 15).

This was the most crucial phase as many issues and aspects were taken into account to achieve an effective final result. As Brame (2015) explains, in order for a video to serve as a productive part of a learning experience, it is important to always consider the following strategies and practices that promotes active learning and engagement: signaling, segmenting, weeding and matching modality.

Signaling, which is also known as cueing (deKoning et al., 2009) is the use of on-screen text (keywords) and/or symbols to highlight important information. Mayer and Moreno (2003) have also demonstrated that this method enhances students' capacity to retain and transfer new knowledge by placing a strong emphasis on organization and connection within the information.

Segmenting and weeding consist in keeping videos under a certain length by chunking/eliminating information that does not contribute to the learning goal. Indeed, Guo et al. (2014) observed that the average engagement time for videos less than six minutes long was close to 100%.

Finally, matching modality is the expedient of «using both the audio/verbal channel and the visual/pictorial channel to convey new information, fitting the particular type of information to the most appropriate channel» (Brame, 2015). For example, it was often decided to show animations on screen while narrating them, giving the viewer dual and complementary streams of information. This practice has been shown to increase students' retention and ability to transfer information (Mayer and Moreno, 2003) while increasing engagement with videos (Guo et al., 2014).

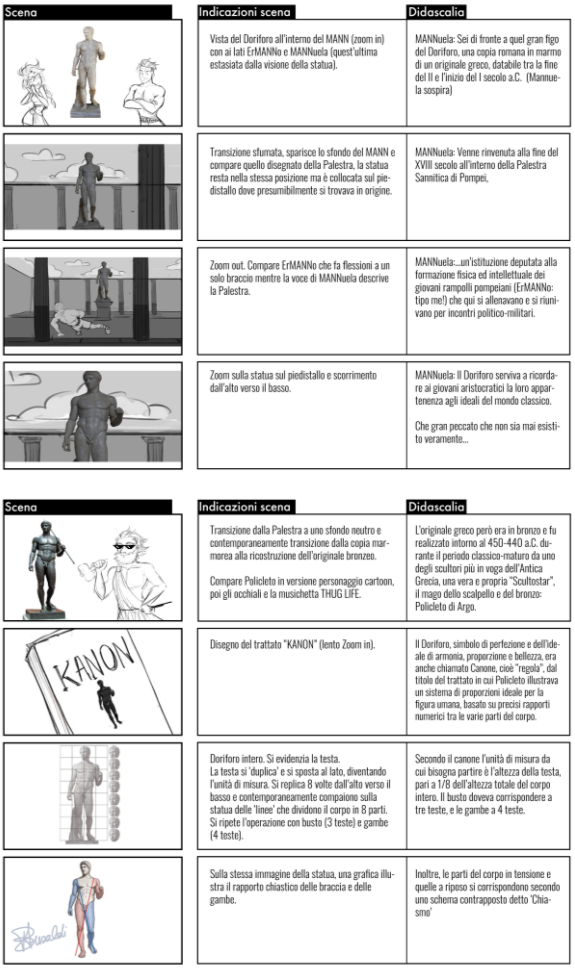

Fig. 15: Excerpt from the Doryphoros video storyboard.

After completing a storyboard, it was first necessary to record the narration so that timing of animations and video editing could be properly calibrated based on the characters' voices, performed by Barbara Ansaldi and Alessandro Ruoppolo. Both characters had to speak relatively quickly and with enthusiasm, because, as Guo et al. (2014) noted, learners engagement depends on the narrator's speaking rate, with students' engagement increasing as the speaking pace increases.

According to the storyboards' development, backgrounds (Fig. 16), illustrations, and any other visual and graphic elements were created digitally with 2D drawing and editing software such as *Procreate* for iPad Pro, *Adobe Photoshop,* and *Adobe Illustrator*. 2D animations were made with *Adobe After Effects* (Fig. 17), both using motion graphics techniques and traditional frame by frame animation (Fig. 18).

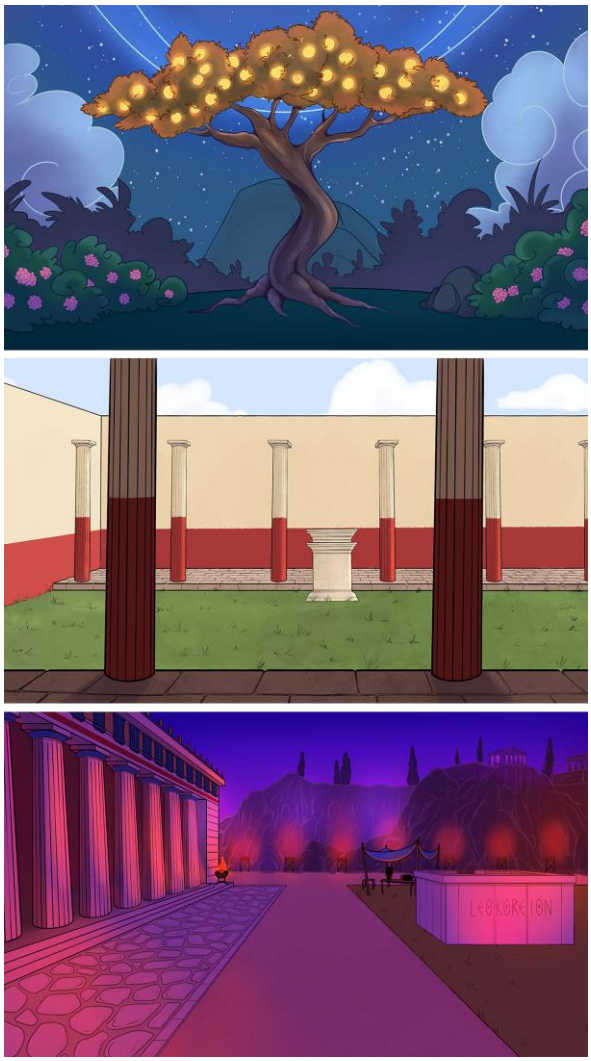

Fig. 16: Backgrounds. Drawings by Barbara Ansaldi.

Fig. 17: Two production photos. From top to bottom: creating a digital illustration with *iPad Pro, Procreate* and *Apple Pencil*; 2D animation in *Adobe After Effects*.

All digital files had to be planned and prepared in advance to serve the animation and editing needs, meaning that layers were carefully set up and exported.

Subsequently, *Adobe Premiere Pro* was used for video editing and compositing. In this stage, royalty free music and sounds were also added, alongside 3D animations provided by Marco Lucignano, who supervised photogrammetric survey of the artworks. The final videos were rendered in Full HD resolution (1920 x 1080 pixel) and subtitled in English to make them accessible by a wider audience both on YouTube and on the official MANN Museum app.

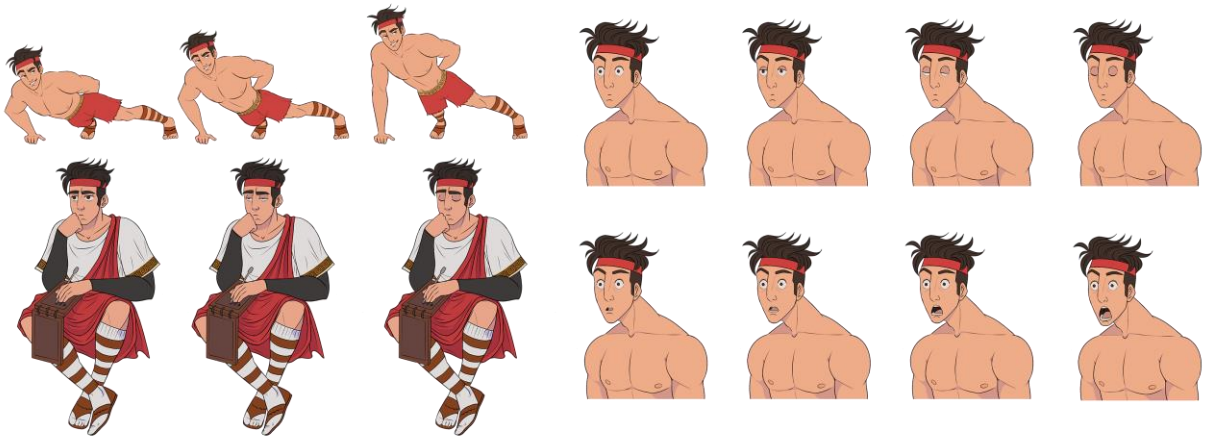

Fig. 18: Frame-by-frame animations. Drawings by Barbara Ansaldi.

7. Conclusions

Dividing the target audience of each video tour into homogeneous groups was necessary to analyzing the needs and characteristics of their different experiential universes so as for designing a customized communication strategy for each group. Consequently, each video tour is particularly suitable for homogeneous groups of users visiting the MANN (Fig. 19).

The SuperMANN video-tour offers groups of elementary and middle school students an engaging support to the traditional museum tour, which in many cases can be boring and poorly understood. The autism-friendly approach allows the inclusion of any student with autism spectrum disorder or, more generally, with any learning disorder that requires an ordered sequence of information supported by a graphical apparatus for an immediate understanding during the visit experience. The possibility of taking the same museum tour together with the class group avoids the frustrating isolation of the person with special needs thus realizing a real inclusion to the class life of all students through the support of the animated videos.

The GigaMANN video-tour is preferred for the enjoyment of homogeneous groups of high school students, whose need for a dynamic, engaging experience based on entertaining narrative modalities with frequent references to current issues in contemporary culture, in which most of them recognize their cultural references.

The UltraMANN tour, designed to induce in the visitor an ideal journey to other cultural places from the works on display at MANN, is offered to homogeneous groups of adults, already accustomed to museum enjoyment, such as groups of tourists, cruise passengers in particular, who have limited time to visit. By following the physical route through the museum and stopping in front of each work to watch the related video, they can appreciate, in about 150 minutes, the richness of the Neapolitan museum through a selection of works from the museum's major permanent collections. But the real strength of the research project, observed in a five-month enjoyment provided to the Mann's visitors, is that it has configured a visiting tool for family groups who, on the basis of learning strategies tailored to specific age groups, can enjoy the museum experience as a time of sharing and exchanging in the family group the knowledge gained in each video tour, while being in the presence of the same works. The effectiveness of the representation and storytelling strategies adopted in the autism-friendly tours were tested and positively verified by about 20 young people from the social cooperative the Tulip. From direct observation of the behaviors and responses provided by users and chaperones, the sequential unraveling of spatiality, shapes and colors enabled the boys to focus on the assets thus highlighted by the immersive experience even during the in-person visit. By recognizing the assets observed in VR as the target of the visit, there was a substantial decrease in fascinations from surrounding stimuli, and users easily headed toward the works already enjoyed in the 360° immersive visit. It is worth mentioning in this research conclusions a single

critical issue encountered during the testing of the autism friendly VR video tour: some children showed discomfort in wearing the virtual reality visor during the museum test. However, the visit experience characterized by interactivity with the museum space was still achieved by exploring the spherical photo of the frescos' rooms using a tablet that was provided to users unable to tolerate the visor. Both in terms of reducing perceptual overload and in terms of comprehension and memorization, the cultural content was still satisfactorily enjoyed.

8. Credits

The biennial research has been carried on by a large number of scholars and students according to the following roles in the project:

- Subjects and screenplays: Alessandra Pagliano, Barbara Ansaldi, Federica Crispo, Carolina Spiezia;
- Content accessibility counseling (autism friendly approach): Erminia Attaianese, Giovanni Minucci;
- Directing, 2D animation, video editing: Barbara Ansaldi, Federica Crispo, Daniele De Pascale, Carolina Spiezia;
- Character design: Barbara Ansaldi, Federica Crispo;
- Illustrations and graphics: Barbara Ansaldi, Federica Crispo, Daniele De Pascale, Carolina Spiezia;
- Digital survey and 3D animation: Marco Lucignano with the collaboration of Laura Papa;
- Literature research: Greta Attademo and Angelo Triggianese;
- Music, voice and sound supervisors: Barbara Ansaldi, Federica Crispo, Daniele De Pascale, Carolina Spiezia, Alessandro Ruoppolo, with the participation of Paolo Giulierini;
- Virtual tour: Marco Lucignano.

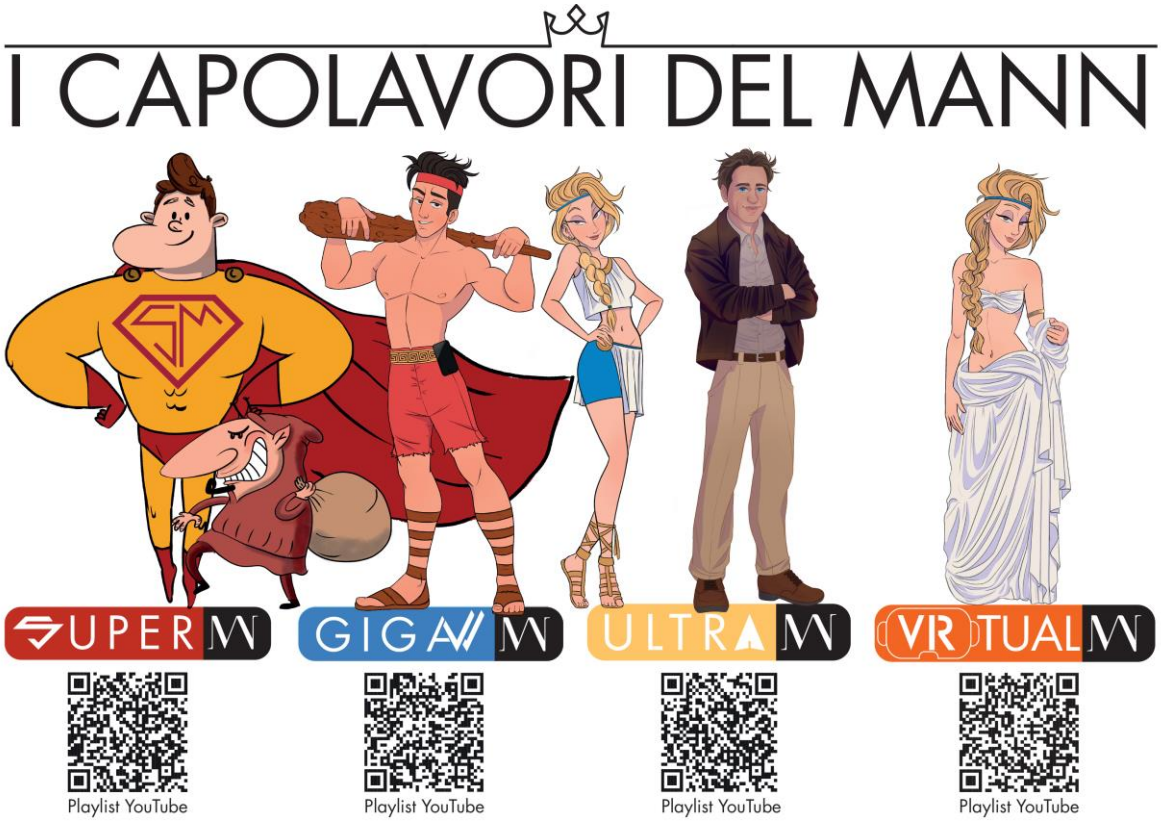

Fig. 19: All the guiding characters and the related QR code to access the playlist on the official YouTube channel of the Mann.

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Although this essay is a joint collaboration, paragraphs 1 to 5 are attributed to Alessandra Pagliano. Barbara Ansaldi is the author of paragraphs 6, 6.1 and 6.2. The conclusions have been written by the two authors.

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