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## Design as Collaborative Connection between User, Technology and Cultural Context

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# Design as Collaborative Connection between User, Technology and Cultural Context

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**Abstract.** Contemporary society is characterized by changes that affect the way we interact with the surrounding environment, in everyday life as well as in the fruition of Cultural Heritage. We are witnessing digital transformations that change the methods of communication and offer new forms of information and dissemination of knowledge, through technological devices that improve the quality and experience of use as well as ensuring monitoring, enhancement and protection of the Heritage. Technological innovations, combined with new forms of interaction and dissemination of information that respect and guarantee accessibility and usability, become essential factors in order to support new ways of awareness and knowledge of culture. The paper gives an overview of digital and robotic systems able to establish new forms of dialogue and promotion of knowledge, through an interaction aimed at accessibility, inclusion and definition of new forms of shared and participatory creativity in which different knowledge and experiences converge. Through a critical-analytical analysis of these systems it will be possible to define the role of design in the configuration of new forms of communication and modes of interaction in order to improve the enhancement and enjoyment of Cultural Heritage. The new possibilities dictated by technological innovation represent the development tools for new models and processes of redefinition of the Cultural Heritage sector and design as an innovator becomes the "tool" for connecting the user, the technology and the context in which it benefits, thus increasing the experiential value and the dissemination of content to a wider audience.

## 1. Digital transformation and democratisation of knowledge

In the contemporary scenario, the new technologies, suddenly rooted in people's everyday life to the point of changing their habits and behaviour, have become an active part of the innovation process in the fruition of Cultural Heritage. What we are experiencing is a phase of evolution and change, a new dimension of the Cultural Heritage field in which new forms of enhancement and use of assets become a strategic resource for competitiveness and a lever for the socio-economic development of the territory, both in national and international policies. Actually, it is clear how much the use of new technologies can contribute to generate new development prospects of an interdisciplinary and innovative nature. «The relationship with information technologies and the world of culture is not limited exclusively to the field of creative production and conservation. The new digital media, in fact, prove to be valuable tools also in the field of study». [1]

The topic is also attracting particular interest in the research field through the promotion of projects at national and international level, allowing the exchange of know-how and experience in the sector in line with the Horizon 2020 Program, which has provided substantial funding, thus recognizing the potential of Cultural Heritage in the field of research and innovation.



In fact, «the presence of industrial and research skills in the cultural production system contributes to the enhancement of the artistic and historical heritage, increasing and promoting cultural tourism». [2] The new reference of the Cultural Heritage field, bridge between technology and art and culture, defines the improvement of the quality of the process as a whole so as to consider the protection, design, use and management of Cultural Heritage. Innovative forms of fruition and promotion of culture in which the relationship with technology becomes strategic through experimentation for the conservation and dissemination of knowledge, considering of primary importance the use of «[...] techniques and technologies up to date that cannot replace but support the methodologies already existing». [3]

Therefore, the transmission of knowledge takes place through the enhancement of the cultural offer, a topic already explicitly addressed in the Code of Cultural Heritage and Landscape [4], focusing attention on the problem of fruition and foreseeing fruition modalities facilitated by the use of innovative tools able to redefine time and space, to involve users in an active way, to emphasize the perceptive aspects of the experience and to integrate the different humanistic and more strictly technical knowledge.

The introduction of technologies represents a great opportunity in order to strengthen and expand the involvement of not only specialized or niche users, but will be «[...] able to allow "anyone" access to forms of knowledge, [so far as to argue] that these technological developments are carrying out a new form of "democratization" of knowledge». [5]

The aim in the use of this digital and robotic systems is to spread culture without decontextualizing and "emptying" the Cultural Heritage of historical, social and scientific content through the promotion and initiation of studies and analyses of broader scope that take into account the limitations resulting from physical, but also cultural, social and economic barriers of access. There is no doubt that the very centrality of the user represents the main element of strength in the renewal of the field.

«Whatever innovation strategy is defined, and whatever path is chosen to implement it, the starting point is always the visitor-individual and the satisfaction of his needs [...] more information content, ways of use, stimuli and opportunities for involvement, but also a greater autonomy in the process of building and managing the visit experience». [6]

Placing human at the center of the cultural process and action is a valid opportunity for change and development of the field together with the identification of policies and strategies that improve the capacity of the cultural system to deal with the rapidly changing society.

## **2. Interactive multisensory experiences between real and virtual**

The places of culture are configured as spaces of in-depth knowledge thanks to the introduction of useful tools for the sharing and dissemination of information. The introduction of digital and virtual systems has changed the experiential and use of cultural contexts by the user, who becomes the protagonist of new and amplified experiences.

«In the age of computerization, with the development of systems that facilitate the knowledge of Cultural Heritage and support the promotion of higher education [...] it becomes of fundamental importance the creation of new spaces and new strategies that favour the fruition and access to places and objects of culture by an increasingly wide and diversified public». [7]

Thanks to the digitization of collections and works of art, the Heritage becomes a common and sharable, accessible and consultable asset, creating a hybrid space between the real and the virtual that goes beyond the physical boundaries of the space that is used.

«[It is possible] to define Digital Heritage as an immense archive, a living memory where experiences mediated by interaction can be made, which goes beyond the convergence of what were once archives, libraries, cultural institutions and cultural industries with their material in an immense digital communication environment.» [8]

The use of technologies and new processes of cultural fruition configure the experience as the complex combination of new contents and interactions with heritage. It is possible to distinguish different types of cognitive experiences; multisensory and "amplifying" experiences able to involve users thanks to the intersection of real, virtual and multimedia environments in a physical context. The user superimposes elements and information on the "reality" with which he or she interacts, passing from the passive and

static fruition to the dynamic and active fruition that favours dialogue and knowledge sharing through hybrid languages and the personalization of the fruitive experience in an emotional and multisensory path. The processes that accompany the digitization of cultural heritage influence individual enjoyment; satisfying personal cognitive needs fosters a direct relationship with the good. [9]

Thus, virtual museums are configured that through the creation of synapses between works of art and technologies, become more performing places. An example of this is the Ruben House Museum in Antwerp, which has included iBeacon technology in its experience of use; thanks to these sensors, users receive information and details about the work of art they are viewing, directly on their mobile device. In addition, these interconnected sensors map the museum, allowing visitors to customize their itinerary within the Rubens House. For each work it is possible to receive in-depth studies and observe details through a system of magnification of the works. The iBeacons are proximity sensors that not only transfer data, but are also capable of receiving information; this technology at the service of Cultural Heritage can offer an experience and interaction between the user and the work through higher levels of detail and allowing the user to personalize their visit, which will become more rewarding and engaging. In order to amplify and enhance the cultural landscape, technologies for visualization have been introduced that improve learning and increase the curiosity of the user; among these, holographic technology is widespread, which allows the reproduction of three-dimensional contents that is projected virtually, altering the real context and returning highly realistic shapes and colours.

In order to improve the cognitive experience and to meet the needs of a public increasingly inclined and predisposed to the use of digital devices, the Acropolis Museum of Athens has experimented the use of digital storytelling technologies. In fact, in 2014, at the museum a software called CHESS was tested that with the support of a tablet offers the user the opportunity to travel inside the museum, connecting the works with augmented reality content.

With the use of digital support, the space is reshaped and "increased" of elements and the user can expand his knowledge of the work through the display of text and images. In addition to the digital experience that the software is able to give back, the ability to customize the experience that is offered to the user is relevant; in fact, through the collection of some personal data, the user is associated with a "person", linked in turn to a distinct type of path, configured according to personal characteristics and preferences. In addition, the system is able to constantly update itself, learning from the experiences and input received from previous users, continuously improving the level of user satisfaction. This allows the user to choose the narrative path that best suits his needs also in terms of prior knowledge and personal interests.

The introduction of technological tools within Cultural Heritage has not only changed the ways of fruition but has generated new forms of art where the work and the fruitive experience merge; in this case technology does not support the user in learning and does not enrich the artwork of information, but generates virtual experiences and a new digital art.

Virtual experiences, characterized only by intangible assets, are able to recreate contexts capable of involving the user and arousing multisensory perceptions, through the only use of digital tools that, interacting with the users, create unique and personal experiences, where, in some cases, the presence of other users can modify the perception of the surrounding spaces.

According to Maldonado (1994) there is «a widespread and increasingly obsessive craving for evanescent worlds, a feverish desire to project oneself, at least illusorily, into the rarefied world of non-things». [10]

The temporary exhibition of the artist Yadegar Asisi at the Das Panorama of the Pergamonmuseum Berlin combines the results of years of archaeological and architectural research with the vision of a contemporary artist, through the digital reconstruction of the ancient city of Pergamon during the period of the High Roman Empire. The user is immersed and surrounded by a 360° panorama where palaces, theatres, objects and settings that take him back to antiquity are depicted.

In fact, the artist has reconstructed the ancient city, through the composition of over 40 photos depicting scenes of everyday life through the skilful use of light and sound, cyclically the scene varies from a daytime setting to a nocturnal one. In this scenario, the user, surrounded by images and sounds, goes

back in time and takes part in life in the ancient city. This creates a new form of illusory experience, offered only by visual and acoustic perception, where the user is passively projected into a new context, immersed and surrounded by a digital dimension.

Technologies such as artificial intelligence and augmented reality also enhance the experiential value of fruition and condition the realization of new forms of art. An example is the digital art exhibition "Machine Hallucination" by multimedia artist Refik Anadol at Artechousem, the artist's first exhibition in New York using artificial intelligence. The exhibition is an experiment in synaesthetic reality, using automatic learning algorithms of over three million images.

The environment, in its dynamism, creates an experience and interaction with the user, becoming the digital experience itself, the artwork to enjoy. The artist uses artificial intelligence as an artistic tool in order to narrate the hybrid relationship between architecture and perception of time and space, amplifying the sensory perceptions of the user, who in this context lives a completely immersive experience and becomes part of the work that surrounds him.

Similarly, the artist Jon Emmony proposes new forms of art, with his installation "Digital falls". (Fig 1) The work is not presented in its physicality but as a virtual installation characterized by elements of digital art.

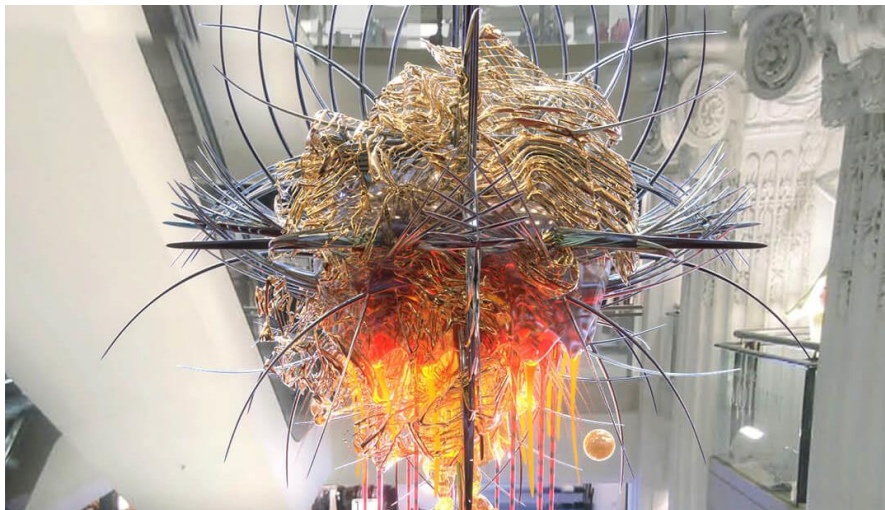


Fig 1 - Digital falls, Jon Emmony

The augmented reality work was created inside the Selfridges centre, where the atrium has been transformed into an inhabited water column by sculptural forms inspired by bio-luminescent creatures. With the use of augmented reality, the artist proposes organic artworks that are displayed by the user with the use of an application, in this way it is possible to superimpose the virtual to the reality, creating new perceptions and interactions between user and artwork. Walking along the stairs of the building, the digital works are modified, allowing each user to live a completely different experience depending on the physical space in which the artwork is displayed.

Augmented reality is not yet a very widespread technology in the field of Cultural Heritage, but it offers numerous potentialities in order to enrich the experience of knowledge and the diffusion of information, transforming the experience into an involving moment where the user does not passively enjoy the works but is stimulated by what surrounds him and enriches the experience which becomes a dynamic and multisensory moment.

A reality in which the immersion of experience becomes polysensory and foresees that natural-real and virtual-digital elements live together in the same space. [11] In fact, unlike virtual reality, where there is a total split between the user and the context, the artworks realized with augmented reality allow a cognitive connection between the subject and the context and promote the sharing of the experience with other users, configuring new forms of digital and shared fruition.

### 3. Robotic solutions for the definition of innovative forms of artistic dialogue

The proliferation of new robotic technologies applied to the Cultural Heritage field requires the help of appropriate skills and diligent monitoring of their use. Numerous are the case studies that put into play the intelligent and effective use of modern technologies in places of artistic and cultural interest.

Currently, robotic systems are used for Cultural Heritage to welcome the user into the museum context, to carry out surveys in sites inaccessible or not available, to monitor the state of preservation of monuments, churches and museums, to improve the accuracy of operations related to the detection. And again, robots for the customization of the routes making the places of culture accessible, safe and exciting through the use of innovative interface devices that simplify the user-machine interactions and amplify sensory perceptions, places where the active involvement of the user is strongly required, accelerating and facilitating the processes of sharing and knowledge.

«The approach to new technologies and their use represents an important opportunity for museum and cultural systems that support and enhance the functions with cultural proposals in which the visitor takes an active and leading role where the needs represent the starting point in order to achieve greater autonomy in the processes of construction and management of the visit experience». [12]

For the definition of the characteristics and uses of these innovative tools it is necessary to start from the main critical issues in the management of Cultural Heritage as in the case of problems of discontinuous attendance of visitors and the presence of spaces not always accessible due to lack of security, because they are being restored or not yet organized for public exhibition. Starting from the identification of two different types of robotic solutions at the service of Cultural Heritage, it will be possible to identify the ways to establish new forms of dialogue and promotion of knowledge, through an interaction aimed at accessibility, inclusion and the definition of new forms of shared and participated creativity. A first case is represented by robotic systems used to support the visitor in the experience of visiting or exploring inaccessible places, thus improving the fruition of cultural sites and enriching the visit with new physical-sensorial experiences. In these cases, innovation is to be considered more in the "service design" than in the technological performance of the intelligent machine.

«The introduction of new technologies to enhance the visiting museum experience is not a novelty. A large variety of interactive systems are nowadays available, including virtual tours, which makes cultural heritage accessible remotely. The theme of increase in accessibility and attractiveness has lately been faced with the employment of the service robotics, covering various types of applications». [13]

An example of a robot belonging to this category is the Norio robot, designed in order to improve the visiting experiences of people with reduced mobility. The robot is therefore "piloted" by the person on the ground floor in order to explore the upper floors of Oiron Castle in Deux-Sèvres, which are not accessible to everyone, given the absence of elevators. Visitors guide the system using a mouse or joystick to explore the different areas of the castle and communicate with people in the same space. This "telepresence robot" therefore makes it possible to create personalised itineraries and active and interactive visitor experiences, as well as representing a technological innovation that responds to the challenges of a moving machine in a historic site open to the public and a revolution in terms of the accessibility of the property itself.

The second category includes those technological systems that change the way of conceiving art, of considering the direct dialogue between artwork and spectator, but also between artwork, artist and technological system that becomes the very means to "make" art. In the current scenario the innovative idea is to create a new artistic field generated by technology through practices of "expansion" of the boundaries of vision and content of art, as in the case of the use of robotics, which becomes the keystone for the revival and revitalization of the Cultural Heritage field.

An example is the humanoid robot Ai-Da, created by Engineered Arts researchers and present in one of the most important galleries in Oxford, a machine with artificial intelligence capabilities in which the artist is both creator and artistic form, thus creating "a performance within performance". Characterized by human features. Ai-Da through a robotic arm creates drawings instantly and composes conceptual paintings that define new and sophisticated means of creative expression. Through the use of cameras inside the eyeballs, the robot is able to see its surroundings, recognize faces and expressions, walk and

dialogue with the people around it. All this is possible thanks to the use of artificial intelligence, a progressive and disruptive force in society as well as in art.

Another example of technology "at the service of art" is demonstrated by the Senseless Drawing bot project which in the exhibition *Artistes&Robot*, hosted in 2018 at the Grand Palais in Paris, highlights the crucial theme of contemporary art, namely the distinction between artistic invention, in its creative and evocative richness and the mere ability to produce an original "machine" that exploits technological potential. Born from the collaboration between So Kanno and Takahiro Yamaguchi the project consisting of a mechanical arm that explores the relationship between technology and art. The result is a self-generated drawing machine that uses the chaotic movement of the double pendulum to dynamically draw abstract lines in real time through the use of a spray can that creates irregular but organic paint strokes and highlights the dynamism of the graffiti drawing process recognized as a form of expression and art.

In recent years there has also been an increase in performances and technology-guided art installations that become attractive forms for the visitor to participate more. The artist Dragan Ilić brings together drawing techniques with the possibilities offered by new robotic technologies, as demonstrated in the *RoboAction A1 D1* project (Fig. 2), in which he combines human artistic sensitivity with the mechanical movements of the industrial robot Kuka, thus experimenting with new painting techniques.



Fig. 2 - Roboaction A1, Dragan Ilić

The multimedia project, based on the need to cross the limits of the human body through the robot as a means of interaction, sees the artist at work on large canvases, drawing with several brushes simultaneously with a robotic arm that becomes the pictorial appendage, the prosthetic extension of his arms. Thus, the machine controls and directs human, transforming a "hybrid" body of human and machine and highlighting the importance of this synergy as a "tool" of transformation in the artistic context and in the creative process.

The introduction of technological means in the artistic-cultural field highlights how new technological discoveries can change the way of thinking and making art, to the point of identifying "artistic" machines that are also capable of inventing, creating and making decisions autonomously. The rapid scientific and technological development is making possible the use of different artistic practices and approaches based on the intersection of several disciplines such as art, science and technology.

#### **4. Processes and tools for the redefinition of shared cultural knowledge**

The digitalization and virtualization of fruitive experiences determine new paradigms of interaction and promotion of Cultural Heritage, reinterpreting and reconfiguring the classic channels of knowledge. The

use of new technologies and tools in order to support the interconnection and dissemination of information configure new spaces for sharing reality and promoting knowledge that transcend physical boundaries. In addition, «digitizing cultural heritage encourages continuous activities of site diagnosis and encourages the emergence of new strands of research and investigation, made available to an increasing number of users who investigate and promote the dissemination and knowledge of Cultural Heritage, protecting and promoting the conservation and enjoyment». [2] The historical and artistic heritage becomes a social and common heritage, where accessibility and sharing will be supported by innovative and digital systems that will bring new widespread knowledge and new cognitive awareness. «It will be sharable, therefore, to sustain that the support of information technologies, used in a scientific key, can configure as an interesting way to travel and investigate to make knowledge an increasingly stimulating and democratic activity». [14]

The current technological experimentation applied to the cultural context broadens and enhances the offer, thus passing from a concept closely linked to material assets, to an additional dimension of an immaterial type, « [...] by virtue of the material and immaterial component that coexist in the asset. Inasmuch as it is material, it is subject to degradation and the passing of time, and inasmuch as it is immaterial, on the other hand, it is the bearer of values and testimonies that must be transmitted to future generations with respect for their authenticity and completeness». [14]

New scenarios are opening up in the field of Cultural Heritage and «there is no doubt that technologies for their enormous potential [...] are to be welcomed, appreciating their positive content, [relatively] to the preservation of the cultural identity of places, the dissemination of culture and the production of new cultural offerings». [15]

New forms of digital art and new cultural "products" are defined, such as shows or artistic performances that broaden the offer of the cultural field, guaranteed also by the possibility from the use of these technologies, now increasingly accessible. The synergy between art and technology has produced alliances and relationships through the relationship of deep mutual influence characterized by the rapid succession of technological innovations. The propensity for innovation and understanding of the advantages and virtuous changes that new technologies can offer, also concern the innovative approach to the fruition of the heritage. This research is linked to the application of technology to art and represents one of the most interesting and avant-garde aspects of the cultural scene in recent years and aims to change the very concept of Cultural Heritage. In this scenario, Design acts as a mediator of connections between culture and technology, through the configuration of tools and processes able to improve the fruition of cultural places for a user who becomes more participatory and aware thanks to the facilitation of communication and narration tools of culture.

«Digital culture is properly understood as "widespread" and refers not only to communication and technological tools and accessories for the visit or to multimedia installations, but to the redefinition of the mission and strategic digital redesign that pervades all processes. It is a question of arking the transition from a purely technical approach to a humanistic approach that defines the new role of the museum, in a constantly evolving context, putting the objectives of cultural growth and organizational sustainability in the foreground, looking critically at the opportunities and limits that the digital brings with it». [16]

The research in this sector is constantly evolving and is following the direction of technological evolution, putting knowledge and innovation at the service of the Cultural Heritage and strengthening the channel of dialogue between user, heritage and technology.

In the following years, interactive technologies and robotic systems will revolutionize the way and dynamics of communication of Cultural Heritage becoming the fundamental asset in order to attract and retain visitors. For this purpose, the focus will shift more towards the innovative and inclusive design of such technological systems able to strategically enhance the exhibition path and placing the visitor at the centre of the cultural offer. Immersive systems that involve the user; «seamless projections and technological solutions integrate with the architecture and installations of museums, exhibitions and shows creating a new and exciting user experience. The visitor is solicited and helped to adopt a different role and is involved not only with the sight, but with all the senses». [17]



Therefore, it will be necessary to configure technological tools of communication and narration and models of cultural dissemination in order to enhance the user's fruitive experience and to promote the heritage, starting from new perceptive-sensorial modes and new visions of heritage. In this way it will be possible to guarantee a conscious and mature fruition of the Cultural Heritage by triggering actions of protection and safeguard as well as knowledge and enhancement. Planning in culture therefore implies, first of all, the recognition of a context, of relationships, of dialogue, and therefore of the understanding of needs and expectations that require to be met in different ways at different levels of accessibility. [11]

\*In this paper, the first and the second paragraph have been written by Giovanna Giugliano, while the third and the fourth paragraph have been written by Elena Laudante.

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