ICT for user-experience transformations in Sustainable - Smart Tourism Projects

VR, AR and MR in Rome's historical center

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This paper explores the user - experience transformations that occur after the deployment of ICT in the redevelopment projects of three archeological - monumental spaces, in Rome, Italy. The study consists in a detailed analysis of their contextual and typological configuration aiming to explain the following: how different is the user experience in these three different Smart tourism projects, how this experience is spatially transformed and how does preserving the cultural heritage through the use of ICT transforms the user experience? The analysis showed that ICT supports new ways of thinking about user experience, while it alters the shaping of this experience per se at macro and micro scales and in terms of the emotional state and user learning path.

Keywords: ICT, Digital Heritage, Smart Tourism, Virtual Reality, Augmented Reality

INTRODUCTION

During the last decade, ICT has gained a presence in tourism for the ability of technology to interconnect commercial objectives with practical approaches for the revival of cultural heritage (Ronchi, 2009). In fact, the methods of creating virtual cultural storages, and digital reconstruction of cultural and architectural artifacts offer multiple benefits to the local culture, tourism companies and tourism themselves (Barcelo, Forte, Sanders, 2000). On the one hand, they help to protect and revive visually information which otherwise would be lost without intervening physically on the cultural artifacts. On the other hand, these methods minimize the impact on the environment

and the local people, while they contribute to generating income and to create new possibilities for employment. Overall, these strategies form the Smart Tourism paradigm, and at a micro scale, they aim at enhancing tourism experience in technologically advanced destinations such as smart cities (Gretzel, Z., Koo, 2016, Portalés, C., João M. F. Rodrigues, Alexandra Rodrigues Gonçalves, Ester Alba, Jorge Sebastián, 2018). At a macro scale, their objective is the achievement of common goals towards sustainable development, and therefore to respond to the challenges of Sustainable Tourism.

The breadth of the influence exerted by the application of ICT on the urban environment from a user

perspective is being also analyzed extensively today (Ratti, 2016). ICT certainly exert data that reveal behavioral and spatial patterns and the ICT monitors use these data in a way to exert some sort of influence on the urban environment. This is true both on the level of new methods and tools available for designing cities (Ratti, Matthew, 2016), as well as on the level of new needs (new services, new ways of living and working) that drive urban development (ITRE, 2012). Lastly, the benefits of ICT in the management and functioning of urban centers is a factor that has been acknowledged by a number of scholars (Engel 2014).

In the case of Smart Tourism for the revival of cultural heritage, however, the presence of ICTs can be of two different approaches that bring different theoretical developments in what regards the user experience transformations. For instance, it can take the shape of sensors or terminals to access public information as it is in any other smart city project, or a mixture of digital data and physical spaces that create smart spaces hybrid in nature. The first category looks at ICT that is user-focused and therefore all the attention is placed on how to attract more users and create friendlier platforms of interaction. The second category of applications is used in areas where much of their heritage is immaterial, therefore in museums and archeological spaces and focus on the exhibited material. These cases basically offer an augmented environment and therefore the users' movement or interaction is irrelevant to the mission. In fact, in those enhanced cases, people are testimonies of a virtual museum which helps the cognitive processes of memory (Gabellone, 2009). In other words, the presence of ICT on the specific sector affects the sense of identity, learning, and culture and therefore alter the spatial perspective users have by the accessibility to new information.

This difference in the application of ICT in the specific sector, has created the question of how diverse is the shaping of user experience and how this experience is spatially transformed? How does preserving the cultural heritage through the use of ICT changes the user experience? As is the case with most questions surrounding design, it is preferable to seek a middle ground between theoretical extremes in order to arrive at the optimal design solution. Nevertheless, is undeniable that the introduction of ICT has altered our way of experiencing a monument or a museum and in effect, they are part of our contemporary cultural imaginary, or zeitgeist. Following this premise, this article offers an examination of how this interconnection can be realized. Specifically, it presents three case studies from Rome and examines the role of ICT in the formation of new enhanced user experiences.

ROME AS A CITY FOR EXPERIMENTING WITH AR, VR AND MR TECHNOLOGIES

A number of initiatives in the city center of Rome reveal a smart district active and emerging. For example, in many different areas there are installed communication networks, GIS based applications, Infrastructure Monitoring projects, among others that constitute the most common Smart City Infrastructure (Al-Hader, M. & Rodzi, A., 2009). In the field of Smart Tourism, Virtual and augmented reality experiences in museums and archeological sites are changing the narratives about the past and the present of the eternal city affecting the way people perceive the sites and their history. The popularity of these techniques in the city center and the quantity of activities happening there usin AR, VR and MR render Rome a very intersting city to experiment. In this framework, this paper presents three cases where this phenomenon is visible.

The first case describes the redevelopment project of the Ara Pacis in augmented and virtual reality. This project combines technologies for the creation of virtual worlds using computer graphics (CG). Traditional green screen filming using real actors is introduced into a 360° built in an innovative software. The second project is the redevelopment project of the Augustus Ex Cinema in virtual reality. In this case, there is a combination of technologies divided into four different experiences: from the development of virtual reality with self-propelled plastics to the expe-

rience of an interactive 3d museum. Lastly, the third is the virtual reconstructions on the existing walls, columns and archeological remains of the Forum Augustus. In this case, the technologies regard the 3d mapping audiovisual projections on the archeological site. At an economic level, the observation of the three places shows that they have given an economic boost to an already strong touristic ecosystem. Furthermore, the generation of the new "hybrid spaces" that combine the virtual and the real and therefore interact less with the built space revealed the affective possibilities of the objects (Hooper - Greenhill, E. 2000, Unesco Portal on Sustainable Tourism). The popularity that the three projects have acquired in the local and international media and the massive attendance of people depicts the significance of the paradigm they suggest.

METHODOLOGY

Our first question is how does the layer of technology alter the user experience? What is the innovation emerged by the application of these three different strategies from the user's point of view? A second, more specific question, regarding the case study, is: How do the three different Smart tourism strategies contribute to the enhancement of user experience and add therefore to the achievement of sustainability in Roman tourism? Following these objectives, this paper analyzes the three case studies, extrapolates the possible effects that technology might have on the social practices and reveals the new nature of the three areas: Archeological spaces prove to be no longer static and linear and museum spaces, artifacts, and visitors (users) engage to an interactive dialogue which transforms the museums themselves in real time 'performances'. As a final reflection, the research aims at establishing a connection between the concepts surrounding the digitization of cultural heritage, smart tourism, sustainable tourism and the broader discussion in the field of urban - architectural design.

The methods applied are a detailed analysis of the three cases, using the techniques of participant observation and documentary research of the three spaces after the application of the ICT. This part establishes the function of the ICT within the context of their display in an exhibition and describes the user experience in an empirical way. For this step, few parameters the authors highlighted: a) the novel spaces that were created to support the reconstruction project, b) the novel spaces that the ICT introduced to the user, and c) the way the users altered their interaction with the building because of the use of ICT. To achieve those goals, the authors proceeded in specialized visits in all monumental spaces, where they collected data coming from their empirical observations and the information surrounding all three sites. After analyzing thoroughly this information, the authors pointed out the kind of transformation the previous analysis brought about in the social practices and tried to build an argument on the user experience formation.

THE CASE STUDIES: ICT DEPLOYMENT IN ROME'S ARCHEOLOGICAL AND EXHIBITION SPACES

For the aims of this paper, the authors present here three different cases: the Forum of Augustus spectacle, the redevelopment projects of the Ara Pacis in augmented and virtual reality and the one of Augustus Ex Cinema in virtual reality. The three case studies appear to be among the most popular in the city of Rome and result in almost all international guiding tours.

The Forum of Augustus was the first one to be launched and was created as a commemoration for the two-thousand anniversary of the death of the emperor Augustus, which took place on August 19th of the year 14. It regards a spectacle, by Piero Angela and Paco Lanciano, and promoted by the Municipality of Rome, projected onto the remains of the forum, making use of the 300 meter surface of the posterior wall, as well as the pavement and the standing columns. The overall technical experience is defined as "an instance of Augmented reality" where an interesting trajectory that links architecture, his-

tory, cultural heritage, sustainable development, entertainment, and education emerges (Geropanta V., Cornelio Mari E., page 47-48, 2018). The contents extend to include cultural, architectural and historical details of all the archeological space and are generated through light effects and 3D mapping techniques. Visitors are expected to be seated at an amphitheatrical seating area, stable and concentrated for all the duration of the spectacle facing the forum and through the audiovisual information they receive, they become active learners.

The second one was the redevelopment project in the augmented reality of the Ara Pacis. The aim of the intervention, promoted by the Department of Cultural Growth of the Municipality of Rome and by the Superintendence of Cultural Heritage was organized by Zètema and carried out by Ett spa. The aim of the project was precisely to allow visitors to enjoy a multimedia story, through which they could discover the original appearance and the function of the altar, but also the transformations suffered over time by the Campus Martius. This project combines technologies for the creation of virtual worlds using computer graphics (CG). Traditional green screen filming using real actors is introduced into a 360° built-in innovative software. During this spectacle, visitors are expected firstly to be gathered seated at a living room area where all introductory - historical part is presented to them. Then they follow a guided tour of five more points surrounding the altar. In each one, they wear AR visors and are able to observe in this way the enhanced reality of the altar.

The third project is called Welcome to Rome where, after the Roman Domus of Palazzo Valentini and the Forum of Augustus and Caesar, the physicist and scientific divulger Paco Lanciano conceived and created it as a new interactive show dedicated to Rome and its millennial history. The show takes place inside the former Augustus cinema, in Corso Vittorio Emanuele. Using technologically advanced instruments, a highly immersive projection tells the 2,700 years of Rome's history in 27 minutes. In this case, there is a combination of technologies divided into four different experiences: from the development of virtual reality with self-propelled plastics to the experience of an interactive 3d museum. Visitors in this spectacle are expected to walk through different rooms where parts of stories are projected with audio-visual means onto plastic models, and end up in the main Cinema area. There, visitors watch a 3d projected film in all walls of the cinema.

EXPERIENCE OF THE CASES: NOVEL USER FLOWS, DENSITIES AND SPATIAL TRANSFORMATIONS

The next subsections present the novel experiences that emerge by the application of ICT in relation to the existing reality of the three areas. The authors here highlight the possible impact of the spectacles in the spatial experience. This is obvious in the moments of user - building interaction and in the way the various working teams that produce the user experience create interdisciplinary knowledge escapes (Blackwell, F. A. et al 2019). The experience of the three case studies revealed a common point: the way the specificities of the various spectacles affect the imaginary and therefore the overall user experience of the archeological sites.

a) VR and AR create new novel experience of the altar of Ara Pacis

For the altar of Ara Pacis, an ancient civic ritual function, dedicated to the Roman goddess of Peace, the project's goal was triple: a) to rediscover the original appearance and the function of the altar, b) to present the various historical moments that led to its final transformation and to c) explain each element of the lavish ornamentation. For this reason, users are encouraged to watch firstly a green screen narrative filming - sat - and then go around its rectangular, uncovered shape (11.65 x 10.62 x 4.60 meters), and learn about all details of sculpting elements on the altar's Carrara marble (figure 1).

The altar is hosted inside the Museum of Ara Pacis, a space designed by Richard Meier. The design concept is built upon the contrast between light and shadow that alternate in sequence. The users enter into a darkened area where they receive instructions and their ticket. Then they access the reception gallery which is semi-permeable, to arrive at the central pavilion that is housing the Ara Pacis, all surrounded by glass. In this area the natural light is filtered through 500m of glass, creating a visual continuity with the outside facade, while retaining the necessary silence to the full enjoyment of the monument (figure 2).

Before the implementation of the MR project (a mix of virtual and augmented reality projections onto the altar and the surrounding space), users usually entered from the two indicated entrances in the main gallery and wandered around the altar with no additional information. During the MR spectacle, the wandering experience changes to support the function of the AR, and VR projections. Users are now passing a sequence of movements (eight in total) starting from the entrance (figure 3) to the pavilion up to the exit of the venue. They are firstly encouraged to rest in the living room created facing the altar (figure 4). There, they wear the visors and watch a green screen film, built in 360 degrees of their vision. At this moment, the audiovisual material introduces them to the history and specificity of the monument. Afterward, once the projection time finishes they are encouraged to follow six steps, distributed in the spaces surrounding the altar. For each one of them, there is material projected through the visors onto the monument. The new users' movement creates also different movement flows and different users- densities. These are periodical as they last for the time of the projection, but repeated as they happen continuously each time the spectacle is projected.

The new enhanced realities created by the juxtaposition of a digital reconstructed surface to the real space introduce two novel spatial experiences. On the one hand, users can see a virtually constructed space based on the narration of the story of the altar which they enjoy when sat to the seating area. The other reveals by the various blended versions of the altar after the AV projections onto it. Both can be experienced only when wearing the AR visors (Sam-

sung GearVR) and when using the cameras inserted into the devices. These devices allow for the virtual and real elements of the show to come together in the spectator's field of vision through an AR application which picks up the detail of the bas reliefs and sculptures in 3D, tracking them in real time. The virtual elements appear to visitors as if they are "anchored" to real objects which adds to the overall effect, the sense of being a part of the scenario (figure 5).

Users in these two new spatial experiences can see different data: some of these reconstruct the imagery of the site's architecture, while others offer a visualization of historical events and personalities. In the first case, the surface designed is superimposed on the altar and builds on the existing architectural elements. In the second case, the surface designed is part of a three-dimensional setting that uses the different depths of the projection perspective to line up with the monument and the building. The digital surface consists of 2D design elements (lines, shapes, volumes) and reconstructs the facades of the altar, architectural details, ornamentation, and materials. Therefore, in design, this surface could be explained as a layer with its special characteristics and attributes. In its full depiction, the layer reconfigures the design form of the altar along with all architectural details. In all cases, the depictions have real dimensions, in 1/1 scale. In other words, it manages to present elements that are inexistent today, explains their transformation in time, and transfers the importance they carry in the urban heritage of the site (figure 6).

The aesthetic product of the spectacle builds a novel imaginary collective knowledge of the altar creating the impression to users that they transform into active participants in an emotional and learning experience.

b) The redevelopment project of the Augustus Ex Cinema in VR
The second project regards the redevelopment of the Augustus Ex Cinema with the use of virtual reality

Figure 4
Geropanta V.,
Karagianni A.,
Parthenios P., 2019.
Novel collective
areas created in the
museum to support
the AR experience

Figure 5
Geropanta V.,
Karagianni A.,
Parthenios P., 2019.
The AR visors of the
Ara Pacis
experience

Figure 6
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projections on the
Altar

Figure 7
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cinema_augustus-
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reconstruction of
the Ex Cinema of
Augustus and its
transformation to
an ICT assisted
Museum space

Figure 8
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lantica-roma-
rinasce-in-
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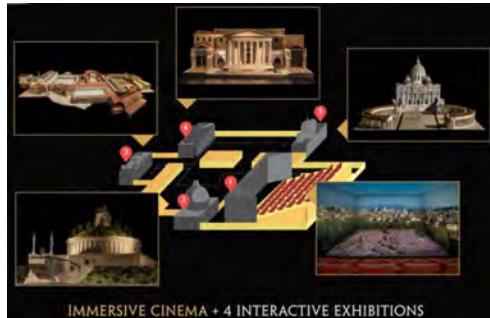to-rome The five
new rooms that
host the MR Reality

Figure 9
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-rome.it/564/ The
ex cinema of
Augustus in 4D
reality

technology as well as MR applications. The difference between this case study and the other two is that projections here take place inside a historical building but however reproduce the material and immaterial cultural heritage of places that are located outside of that space and inside the historical center of Rome.

For the purposes of this mission, a whole ground floor space was reconstructed to accommodate the various spectacles (figure 7). The plan was divided into four smaller rooms (figure 8), wherein each one of them there was a presentation of a piece of the story with audio-visual means enhanced by a 4d back tickler. In the same plan, the initiative predicted also the redevelopment of the ex-cinema of Augustus to a venue that could include several physical effects to install a 4d movie (figure 9). As a result, the implementation of ICT in the specific project required two different initiatives: a) the transformation of an open plan space to a traditional path exhibition area, and the refurbishment of the cinema along with the integration of technologies for the 4D experience.

In the new exhibition space, therefore, there is a combination of technologies divided into four different experiences: from the development of virtual reality with self-propelled plastics to the experience of the 4D auditorium. In a straight, bearly illuminated space, the users are guided through a serial list of events after having acquired their headphones and ipads from the reception. The ipads serve as mediators with the sensors installed to the wall surfaces of each room. In fact, outside of each room, there is installed a small sensor that allows for the starting of each spectacle which means that this machine to machine interaction with the users' contribution is the one that allows for all the didactic process to happen. From these interactions there generate a number of novel experiences in each room which alter the users flows and density in the various rooms. Opposite to each seating area, there is a theatrical screen, horizontal or vertically expanded with the presentation of each monument under examination (figure 10). People are expected to be standing in front of this screen which consists of a plastic model onto which

the information is projected under the means of virtual reality.

As the time of the narration is passing, different parts of the model reveal, and with lighting effects they create a strong learning experience.

In the cinema, a large venue presents a 4D version of a wide - release 3d film (figure 11). This means that the experience of the projections create an enhanced reality since it consists also of effects simulated in a 4D film such as strobe lights, and vibration. The seat effects include smoke, and lightning coming out.

Users in these new spatial experiences familiarize with three different technological instruments that collaborate to offer the above-mentioned experience. These are the sensors following all of their flows inside the different rooms as they use them to generate the starting moments of the shows. Then users get familiarized with the reconstruction of the archeological stories through the use of 2d line projections onto the plastic models. These help them not only

perceive the different construction materials but also the different construction stages. Lastly, as they all gather to the new projections venue, they watch a 360 degrees audiovisual material and also become part of an emotional experience. These changes are not periodical but the authors argue that they are episodical in the sense that the ICT, in this case, alters once and for all the users experience in the space.

c) AR projections in the Forum of Augustus

The third case study is the virtual reconstructions on the existing walls, columns and archeological remains of the Forum Augustus with the use of AR technologies. Specifically, users experience the result of 3d mapping audiovisual projections on the archeological site assisted by headphones with the recorded stories (figure 12). Specifically, all the materiality of the monument material and missing is set in complete visualization to the users. This allows them to immediately understand in detail the value of the existing landscape, restoring all the details that would be impossible to physically perceive. The implementation of ICT in this case, entails a methodology to make indistinguishable the digital and the real images through the animations, while it preserves the monument in its original state (Gabellone, 2009). The result of this activity is the transmission of information to the visitors, offering the wider public an important opportunity to learn.

Before the implementation of the AR, project users were the regular visitors of Via dei Fori Imperiali, an

axis that connects Venezia square and the Colosseum. As this area consists of five compounds, all remaining frozen in the archeological site there was little information related to its specific story and architecture. There was also very little human interaction with the archeological site as the Forum is three meters lower than the walking area. During the AR spectacle, the wandering experience transformed completely into a theatrical instance. Users are now part of an ancient Greek theatrical scene, situated in an amphitheatrical seating area. There, they wear headphones and watch the spectacle. At this moment, the audiovisual material introduces them to the history and specificity of the monument. The users are offered in this way an important opportunity to learn, in a method that has the impact partly of an ancient Greek theater partly a short of distance museum piece, given at the disposal of the visitors (Geropanta V., Cornelio M. E., 2018). This leads users to think that they are testimonies of a virtual museum, which helps the cognitive processes of memory (Gabellone, 2009). Once this collective memory is built, then as a whole, the aesthetic product transforms the original experience and builds a novel imaginary collective landscape. Lastly, since the impact of such a learning experience is strong, it is considered that the effect creates spillover effects in the surroundings, that in turn offers to users emotions for understanding, learning, safety, belonging, and admiring (Geropanta V., Cornelio M. E., 2018).

This context extends not only to the understanding of the micro scale, but also to the extent of perceiving the reality of the compound in relation to its surrounding compounds. The three-dimensional reproduction of each of the components of the forum allowed for further understanding of its urban context and the underlying system of relationships with the surrounding monuments, which becomes an important guide for the comprehension of the architectural strategies that have been followed in site (Graham Shane, 2005).

NOVEL SPACES AND INTERDISCIPLINARY KNOWLEDGE ESCAPES EMERGING FROM THE INTERACTIONS BETWEEN TECHNOLOGY AND ARCHITECTURE

The three case studies revealed that the actual transforming experience can be either 'episodic' or periodic' (deLahunta, 2002). This means that ICT does not always cause foundation-shattering impacts on user experience but when it does this experience changes in massive ways. In their being episodic and by engaging a finite number of actors, their impacts are reduced in scale. In their being periodic and by engaging a less or finite number of actors their impacts become stronger. Yet, the authors would like to argue that there is more to these interdisciplinary encounters than their tangible, project-bound outcomes. To understand how their impact builds up in time it is useful to look at the process of integration of the VR, AR and MR technologies in the architectural space not only at micro but also at macro-scale. At microscale, observations are done to the artifacts and the way people see them more complete or more holistic. At macro-scale, we look at how the specific examples lead to the emergence of new, interdisciplinary constructs, theories, approaches and techniques and eventually lay the foundation of new interdisciplinary methods of analyzing the user experience results, solidified by the foundation of new professional roles, academic departments and curricula.

In the three case studies, the authors argue that the process of integration happens simultaneously at micro and macro-scales, influencing and feeding into each other. The more different types of interdisciplinary encounters concentrate on a timeline, the greater impetus and momentum is created for new, interdisciplinary spaces that blend the thinking, resources, theories, and methodologies of diverse fields.

At a physical level, novel spaces are produced in all three cases, such as a) the collective new seating areas, the spaces where all projectors and cables are installed. It regards the material/physical use of the existing space, which is transformed into a place that

hosts all projectors and relevant technologies. The overall space where this hardware is gathered overlaps with the archeological site, hidden to the viewer but nevertheless present. Furthermore, new spatial entities host exhibiting material.

From an experiential point of view, the fact that the artifacts are not frozen in time, and reveal in their totality to the users. This adds to an overall effort of making visitors get the maximum of their experience in the place, and reinforce the cultural memory, in the context of which "the distinction between myth and history vanishes" (Assman, 2008, p. 113). In this way, the aesthetic decisions reconcile a memory, an identity, and build in the visitors' consciousness the idea that all data belong to a specific cultural community.

Other results deriving from the case studies are the following: a) the creation of a visual connection among the different places where projections happen simultaneously; b) the transformation of regular visitors into active participants in an emotional experience; and, c) the transformation of regular visitors into active participants in a learning experience. All the above allow for the creation of an interdisciplinary knowledge scape and of a reinforced experience.

CONCLUSIONS

We have proposed a contribution to the field by analyzing the three case studies from the user's point of view. It emerges from all cases that the implementation of ICT in the specific cases brings a different experience of the sites that could have implications in many different states (e.g. emotional, psychological, physical, etc). In all cases, the exhibited areas transform to 'smart spaces' full of meanings of the past, mixed with the technology of the present. In Ara Pacis, the AR layer creates two novel digital spatial perceptions and a number of new movement flows and people densities throughout the building. In the Ex Cinema of Augustus ICT revive and reveal to the observer new ways of understanding and analyzing the history. The new digital designed layers, projected onto the physical models and assisted by 4D techniques, contribute to a sense of participation to a museum exhibition. Lastly, in the Forum of Augustus, the audiovisual projections present the thickness of meaning that exists behind the frozen in time monuments, thus, contributing to a renewed sense of identity, origins, and knowledge for all visitors. Although the new digital layers are constructed with the aim to add details to the monuments, in the end, they create a new method of enhancing the interaction between user and monument. This method brings a different experience of the sites that could have philosophical implications and is therefore suggested as important to study and experiment.

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