NEUROSCIENCE AND PRESERVATION
How digital technology has been changing the experience (and the way we take care) of heritage

DAVIDE DEL CURTO[1]

[1] *Department of Architecture and Urban Studies, Politecnico di Milano*

ABSTRACT

Life is increasingly being conditioned by the widespread digital technology and by Internet. They have also entered the field of historic heritage and conservation for a long time, with academic researches, high-skill job opportunities in the field of 3D survey and modelling, dissemination and services to the public. To what stage is the relationship between digital technology and historic heritage?

These lines offer some hints, starting from recent outcomes in the field of neuroscience investigating as the Internet and digital technologies has been changing some of the core functions of our mind, such as the ability to pay attention and remember. Can historic heritage play a role in this process? What consequences to the conservation field?

Keywords: heritage conservation, memory, digital technology, virtual reality

Conservation is nowadays an autonomous discipline, since heritage was recognized as a capital asset. Heritage conservation is thus an economic sector with many professionals and interests involved. Nevertheless, conservation has been a field of social commitment for decades. Building conservation, in particular, has defended the historic cities against the pressure of urban speculation in Europe for two centuries, since the rise of modernity to the post-crisis reaction. A certain primacy of practical aspects and application technologies in the field of conservation has to be traced back to the early 1980s when the hard sciences entered the field of conservation and moreover of building restoration. Chemistry, physics, mineralogy, etc. have thus found a great opportunity of development in these areas, for both research and industry, from the production of special materials for strengthening or hi-tech systems for surface cleaning, to the large chemical industry of polymers for the building and restoration sector.

As a consequence, it has recently been observed that the so-called contemporary theory of conservation focused on the conservation activities and professionals, more than on the value-base for such an activity (Munoz Vinas, 2012; Clavir, 2002). The framework of cultural values where conservation of built heritage rests on has significantly changed in the last decades. Conservation is inherently a part of modernity, since it has developed in Western Societies in the late XIX century, as an intellectual reaction to industrialization and urbanization. Some architects, historians and intellectuals looked for tangible objects, which could be preserved, reminding of the past and thus criticizing such a way of development. The effort was to define the past as a positive world and different from the one we live in (Lowenthal, 1985). Conservation has aimed to make the past possible to relive by preserving the tangible evidence of its existence, that is heritage. This way national identities have been built in the XX century. More recently, the so-called cultural turn has stressed a postmodern view on cultural heritage as the product of uneven power relations in our society where weaker groups lack the possibility to define what they believe is worth preserving. According to this view, such a possibility just belongs to the experts of heritage, which

may represent the ethnic majority in society (cultural imperialism). Conservation has thus been criticized for its tendency to consider heritage as a field exclusively defined by experts (Smith, 2006).

Conservation has then been asked to follow the shifting political views and changes in society such as de-industrialization, immigration and the quest for inclusivity in the global climate change scenario. Nations are today only one of the places where collective identities take place, along with the biggest cities, the Mediterranean basin or the European community. They are understood as a mosaic of ethnicities where, at least theoretically, every piece has the same value. Since late XX century, the attempt to update the value-base for Europe has stressed the idea of a community not primarily based on national, but rather on ethnic identities. The cultural pluralism of Europe is nowadays challenged by a number of identity markers such as class, gender, generation or lifestyle, and there is no longer a consensus that cultural heritage is a resource of benefit for the whole society, but rather for groups or even individuals. In such a scenario, a question may be: whose values building conservation is thus preserving?

We may ask conservation to be up to date in a rapidly changing society, to acknowledge the social quests of multiculturalism, community involvement and local development. It means to re-assess the cultural, economic and social values of the built environment, even asking if values are still so intrinsic to the materials of a heritage building (Avrami&Mason, 2000) or if they are slightly moving to the virtual image of heritage. In fact, life has increasingly being conditioned by the widespread digital technology and by Internet. They have also entered the field of historic heritage and conservation since a long time, with academic researches, high-skilled job opportunities in the field of 3D survey and modelling, dissemination and services to the public. In this perspective, we may consider some updates to the relationship between the real historic heritage, e.g. an object, building, landscape, and its digital image, which has been the object of debate since years (Dezzi Bardeschi, 2005). More specifically, we may consider some recent outcomes in the field of neuroscience investigating as the Internet and digital technologies has been changing some of the core functions of our mind, such as the ability to pay attention and to remember. What role does historic heritage play in this process? What consequences to the conservation field?

A good example is a recent experience occurred to myself while preparing some photo renderings of a decorated room at Palazzo Diotti in Milan, which is undergoing restoration to remove the monochrome painting of the 1980s in order to highlight the previous decorated walls. Photo renderings were to predict and illustrate the possible outcome of the restoration, based on the already existing stratigraphic essays. Palazzo Diotti was built in the 17th century, restored in the 18th and 19th century. The point was to determine how many layers of paint to remove that is to decide whether to highlight the 19th or 18th century decoration. When the restorer began to remove the painting, the sequence of decorations concealed under the most recent revealed as we expected. We thus decided to remove the 20th century layer (worthless) and the 19th century (very deteriorated) to highlight the 18th century decoration. After removing several square metres of both layers, the restorer revealed how much the 18th century decorations were difficult to recover as it was much more deteriorated than I had designed with Photoshop. At that time, my first thought was not "you have to find another solution" but "press CTRL+Z".

Though only for a while, my technology-accustomed brain thought I could cancel an erroneous action in the real world just as I am accustomed to retouch a bad imagine on the computer. This made me reflect about how much technology is actually changing the way we live, from doing digital shopping, to the way we communicate and work. Technology has penetrated everyday life so deeply that the more we spend time online, the more the border between "real" life and "virtual" life tends. What impact may such a pervasive technology have on the core function of our brain? What consequences to historic heritage?

Neurosciences have been exploring how the digital technologies may affect our ability to pay attention and to concentrate. Everyone has experienced how the ability to concentrate for hours is challenged by the fast and tech-driven world we live in. According to a research published by

Microsoft, the ability to pay attention decreased from 12 to 8 seconds between 2000 and 2013. Our attention dropped because we are so stressed with new information that if any content takes longer than a few seconds, our brain starts searching for the next hit of excitement. In fact, the number of "jolts per minute" is the unit of measure for media content producers and advertisers to comply our demand for new information via TV and mobile devices (a "jolt" is a change in action that keeps us watching a show). Our reduced attention spans links to the so called "attention economy":

> the wealth of information means a dearth of something else: a scarcity of whatever it is that information consumes. What information consumes is rather obvious: it consumes the attention of its recipients. Hence a wealth of information creates a poverty of attention and a need to allocate that attention efficiently among the overabundance of information sources that might consume it (Simon, 1971)

Historic heritage is not immune and may benefit or disadvantage from the "attention economy" depending on how heritage would be able to stimulate this constant demand for new information. Heritage is then called to produce images able to capture attention when viewed on the small screen of a mobile phone or tablet.

A recent example is the Paleo-Christian Basilica in Siponto, Italy. The archaeological remnants of the basilica were used as the basis for building an artistic installation consisting of a 14 meters high wire mesh structure suggesting the "wireframe" volume of the ancient basilica. After an initial phase of general agreement, a heated debate has recently sparked about this achievement weighing seven tons and costing 3.5 M€. According to the supporters, the "wireframe" volume would help site visitors interpret the archaeological remains. For sure, the operation was done with great care for communication via TV, newspapers and Internet. Edoardo Tresoldi's artistic installation has certainly been able to capture the attention on the web, where ita image has been displayed millions of times. In fact, the pictures of the large metal structure, often taken in the warm sunset light, are much more seductive than those showing the only archaeological remains, especially when they are viewed via the small screen of a mobile for a few. If the mediatic resonance is above all due to the figurative value of the artistic installation, we could wonder if this installation actually brings some kind of benefit to the archaeological remains. In fact, according to the opponents, the wide and heavy metal structure does not protect the archaeological remains and, on the contrary, it carries them an additional weight and exposes them to the risk of contamination due to rust (Pane, 2017). Siponto's archaeological area has certainly greatly increased its notoriety thanks to the large number of on-line visualization of the artistic installation. In the next future, they will need to evaluate whether this greater virtual site reputation will have a positive effect on the real archaeological site, both in terms of better conservation and in terms of valorisation, e.g. resulting in a greatest number of visitors.

PICTURE 02

A second example is the international competition promoted by the City of Verona in 2016 to design a roof protecting the Roman amphitheater from the weather. Most of the entries to this competition have proved to be of high architectural quality and supported by interesting solutions both from a constructive and from a historical/philological point of view. Some proposed an updated and hi-tech edition of the ancient *velarium* once protecting the *cavea*, despite it was more a protection against the sunlight, than against the weathering. Similarly to the case of Siponto, the media effect of the competition, here condensed in a couple of highly imaginative photo renderings published by newspapers and bloggers, has produced the media resonance that was so desired during the election period, when the architectural competition was promoted. However, it is quite evident how the idea to cover a roman amphitheatre is hard to translate in an effective solution both on the architectural and on the archaeological point of view. A high-tech structure risks being inadequate to such an ancient building, and disproportionate to the problem it aims to solve. It was in fact the case of the Roman Amphitheatre in Nimes, which was covered by a tensile

structure designed by René Chambon in 1998. The problem of humidity had already been discussed since the early 18th century by the conservators of the amphitheatre which developed several solution to protect the monument by stopping the rain from penetrating the masonry structure (Maffei, 1728). The *cavea*, in fact, may be seen as the roof of the amphitheatre, while the steps of marble where the audience seats on, work as the tiles of a sloping roof. The mortar joints among the steps are thus responsible for protecting the building structure by the rain. Along history, these joints have been subjected to permanent maintenance to fight their seasonal decay due to sun and weathering, even thanks to specific studies assessing the best materials and executive techniques to make them more and more durable. The research on the materials to seal the mortar joints has been updated over the past ten years, to develop an effective procedure to make the *cavea* water-proof (Cofani&Del Curto, 2012). When the hangover of the hi-tech roof will have passed, these researches will work again on the serious issue of protecting the amphitheatre from moisture and decay, by much simpler and cheaper solutions, based on planned and seasonal maintenance (Castiglioni&Cofani, 2017).

==PICTURE 03==

Another way technology threatens our ability to pay attention is by forcing us to constantly multitask: we chat on WhatsApp as we attend meetings, browse Facebook while we prepare a meal, check the e-mail every five minutes while writing a paper. It has been noted as this is an induced and unwanted condition that increases our level of stress. It has also been observed that our brain is not naturally suited for dealing with multiple items at the same time. For this reason, instead of increasing our productivity, multitasking reduces our efficiency:

> We can't multitask well, no one can. (…) What we're actually doing when we think we're multitasking is just switching back and forth between tasks (…) We overestimate our ability to focus – so when you're concentrating do one thing and close down multiple screens and windows to avoid distractions. It also symbolically signals to your brain you need to focus. (Chatzky, 2016)

Even the historic heritage can be damaged by this constant urge to multitask, since it is likely to be reduced to one of the many fleeting items our mind is called to cope with. On the other hand, heritage can also be a refuge from this constant threat. In fact, when we experience a piece of heritage while studying, restoring or simply visiting an archaeological site, a historic building, a collection in a museum, we are subject to a demand for high-quality attention. This naturally supports our spontaneous weakness to linger in the dozens of distractions that would lead us to squander our attention into irrelevant fragments. It does not mean that enjoying a monument, a historic building or any other piece of heritage is necessarily a boring experience or a strain on our mind so much as it can not be counted among the pleasures and leisure to which free time is reserved. On the contrary, the real experience of historical heritage is an oasis where we finally put in stand-by all the items looking for short and immediate answers and where we can instead continue to exercise our ability to think deeply.

Instead of reducing the richness of our historical heritage to the contingent needs of multitasking, we should focus on its naturally polysemous content. In fact, every monument / document embodies a number of different meanings and messages that can be decoded and interpreted at different levels and to the benefit of different users. This is a particular task for museums, where specific paths are conceived for each kind of user. Galleria Nazionale delle Marche – Palazzo Ducale di Urbino, is a good example. Along with the traditional diversified routes for children, boys, experts, etc., a path has been specifically developed for low vision users. Digital technology has been helpful, e.g. by facilitating the creation of 3D models that allow blind people to "see" some of the major Renaissance masterpieces through the touch and other senses (Clini et al., 2017).

3D modelling has long time entered the field of heritage conservation long time ago, since it has been initially a support for topographic survey and design. The model represented the point of

arrival of a topographic survey, performing an interpretive and critical function of the collected data, along with the presentation of the results. Since laser-scan has been more and more in-use, this sequence has been reversed. The model is no longer the result of a topographic survey campaign, it is instead a semi-worked phase to be used to obtain the final projective views such as plants and sections at any scale.

More recently, 3D modelling has been collaborating with the augmented reality techniques, for example by expanding the content available to users when visiting a historic site. The case of the museums of the Marche, testifies to a clever use of 3D modelling to create paths accessible to blind users. Beyond augmented reality, also virtual reality has been bearing some interesting experiments, especially when it is used as a tool to perform virtual reconstructions that suggest the aspect that a certain good or historical object has had in the past. In this sense, the application of Virtual Reality to historical heritage presents very interesting and still largely unexplored potential. The Ara Pacis Museum in Rome is a recent example where VR tools have been applied with interesting results. The Ara Pacis is one of the major legacies of the Roman Empire as it is an altar dedicated by Emperor Augustus to the "Pax Romana" in 9 BC. The Ara Pacis was neglected during the Middle Age and was recovered only from the 16th century. In the 1930s it was placed in a large display-case-shaped building along the Tiber River. Since last year, the "Ara com'era" (Ara as it was) exhibition allows you to visit the monument with the aid of a pair of glasses for augmented-reality. The visit consists in a walk around the monument along nine points of interest (POI). Each point provides 3D multimedia contents telling the characteristics and history of the Ara Pacis (Archeomatica, 2016)

PICTURE 04

Beyond the playful aspect and audience appeal, it is interesting to use the augmented-reality devices as a tool to show a hypothetical, though philologically well-supported, reconstruction of the aspect the monument had when it was built. Sophisticated digital images effectively enrich the storytelling, without affecting the material authenticity of the monument. For example, looking at the Ara Pacis through the viewer, you may see a simulation of its surfaces as they were coloured in antiquity, though colours are evidently virtual. It is then interesting to observe as the use of such portable device allows a visitor to enjoy additional contents just as he / she is visiting the monument and physically interacting with it, for example walking around. As a visitor enjoys the real and virtual content at once, he / she spontaneously appreciates the difference between the authentic value of the real monument and the contemporary and experimental value of the image representing a research hypothesis (Bacca et al. 2014).

More than attention, memory is perhaps the brain ability most seriously affected by digital technology. The so-called "Google effect" represents a fundamental shift in how we remember by using the Internet to outsource our memory storage like a remote hard disk. In 2011 a seminal study by Columbia University explored the way we use our memory since we have Internet. Results show how the Internet has become a primary form of external or transactive memory, meaning that we use it like spare storage for our brains, filing many information like memories, things we have done or studied. Before the Internet allowed so many data to be immediately available to users, when doing a research, you did need to consult an expert or go to the library and find the right book. Being aware of this process and the labour it demands, we were stimulated to store such hard-earned information. Now we know we will be able to access the information again when we need it, and we thus choose not to remember just because we do not have to. This may have relevant consequences, e.g. reducing or changing our ability to focus onto details, as when we encode information we tend to do it more superficially.

The "Google effect" also affects our most basic functions, like our navigational ability. Researchers have recently studied that the instinctive ability to keep the orientation by figuring the right route from a place to another, takes place in a specific part of our brain, which stops working when we use a satnav for long time (Javadi et al., 2017). Using a satnav puts in a sort of stand-by some parts of the brain that would otherwise be used to simulate different routes. The "Google effect" does not make us less intelligent, but our brain (particularly some parts) is just less

engaged. It is thus vital we keep memory fit, not to lose mental agility. Our mind, in the end, is able to quickly react to an external stimulus and to adapt to the environment. Therefore, it is not surprising that our concentration and memory capacity is changing in an environment dominated by digital technology and the Internet. We may guess that if we devote less resources to storing information, this can free up space and mental energies for other activities, hopefully creative or inventive.

Historic heritage can play a role in this process, because when enjoying heritage, you need these faculties in use. When visiting an archaeological site for instance, you are called to mentally rebuild the image of the lost buildings or city on the basis of the view of the remains. This exercise requires attention, memory and orientation skills. The fact that orientation helps memory to fix images in our brain had already been known since centuries, as testified by method of *loci* already used by Cicero (Wilkins, 1963) or the "architectural mnemonic" described by Giordano Bruno in the "Art of memory". "Architectural mnemonic" is a technique to enhance memory based on the use of places to be memorized according to an architectural scheme or path. It consists in memorizing a sequence of rooms by visualizing them in the right order, just as if you would walk through them. This method can be applied to remember a speech, breaking up the content into images to be memorized, and placing each image in a room of the building previously memorized. The parts of the speech can then be easily recalled by imagining you are walking again through the same path, visiting each of the rooms in the right order and thereby recomposing the speech. This is similar to what we experience when being on a heritage site, as we are stimulated to remember what we have previously studied on the basis of texts and pictures, on a book or a video. This instinctively happens in front of the real thing, as if memory was there looking for a confirmation by operating a sort of self-digging process which has recently been studied by neurosciences investigating the archaeological dimension of the mind (Panksepp&Biven, 2012).

Therefore, the experience of heritage helps use to keep these faculties fit, fighting our tendency to loose our memory ability. Neurosciences have investigated how some emotional systems, which originate in deep areas of the brain and are remarkably similar across all mammalian species, may explain how we live and behave. This field of research has then studied the role of the emotions within a cognitive process, following the seminal research by Antonio Damasio about the dualist separation of mind and body (Damasio, 1994). Damasio and others' studies succeeded to locate the brain areas in which these emotions originate, particularly the cerebral cortex. This finding made it possible to establish a neurological correlation between the brain areas responsible for the emotional reactions and other areas, where cognitive functions are located, e.g. the memory. This allows supporting from a physiological and clinical standpoint that emotions play an important role in the memory process.

This renewed awareness recalls the late 19th century studies investigating the hypothesis that the experience of figurative arts is not only entrusted to the sense of sight, but to a wider number of body sensations. The main one was named Einfühlung, that is a sensomotorial sensation produced by the experience of visual forms, later translated into English with "empathy" (Mallgrave 2013, pp. 105-6). The history of art has often considered the many perceptual aspects associated with the expanse of a work of figurative art, that is, the sensations we feel when observing the colors, muscles or gestures of a drawn or carved figure. The English writer Violet Page (otherwise known as Vernon Lee) during his stay in Florence, even attempted to study the physiological changes of people observing the façade of the Church of Santa Maria Novella by Leon Battista Alberti (Mallgrave 2015, 24).

This is nowadays true more than ever, precisely with reference to the direct experience of historic heritage and its authenticity. The onsite experience of a historic, architectural and archaeological heritage is thus a source not just of powerful images but also various multisensory stimuli which arise deep and diverse emotional reactions in anyone, depending on each person's background of experiences and memories. The experience of historic heritage is therefore something still authentic and largely non-replaceable by virtual reproduction.

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PICTURE 01
Stratigraphic samples, photo-simulation, a phase of the ongoing restoration in Palazzo Diotti, Milan
Photo: DDC

PICTURE 02
A 14-metres tall wire mesh installation reproduce the shape of the 12th century Basilica of Santa Maria in the Archaeological Park in Siponto, following the shape of the remains (Ministry of Cultural Heritage and Tourism, Superintendence of Puglia. Artist: E. Tresoldi; curator: S. Pallotta; structures: Cobar SpA)
Photo: B. Mondelli/gigart.altervaist.org

PICTURE 03a
Architect R. Ventura was awarded 3rd place within the competition for an openable roof to protect the Roman Amphitheatre of Verona from the decay due to weathering. A central ring over the arena is supported by exterior slender columns not affecting the walls. The cover made of sheets takes inspiration from the ancient canopies.
Photo: Comune di Verona/3Arc Studio
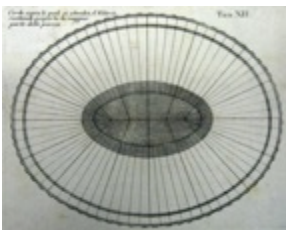
PICTURE 03b
Plan of the velarium over the Arena in Verona. Engraving by Scipione Maffei, *De gli anfiteatri, e singolarmente del veronese,* Verona, 1728, pl. XII. COARELLI, F. & FRANZONI, L. *Arena di Verona: venti secoli di storia*. Verona: Ente autonomo Arena di Verona, 1973

PICTURE 04
Since 2016, the "Ara com'era" exhibition allows you to visit the monument with a device for augmented-reality providing 3D multimedia contents and suggesting how the monument has changed during centuries
Photo: arapacis.it