Innovation and Technology: knowledge paths for a contemporary fruition of Archaeological Heritage

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Abstract
The identity consolidation which takes place in giving value to the historic and archaeological heritage, can find a key-point in the technological innovation, if this one is conceived as an instrument at the service of knowledge and of its widespread communication.
This contribution shows a design experimentation for the physical and virtual fruition of a singular proto-historic site: the Early Bronze Age Village in Nola. This discovery, unique of its kind, allowed the reconstruction of the physical and social organization of the Village. The design experimentation has been the occasion to verify the applicability of technologically advanced information tools whose aim is the realization of personalized knowledge paths. The use of the *Augmented Reality* increases the perception and interaction of the user with the environment which is enriched with visual, graphic and textual information, synchronized and developed in the virtual space, that the user cannot directly observe with its own senses. The perceived effect is that of a virtual space which coexists with the real one, in which the user is free to move, interacting with it. As a support of the system, the project expects the realization of punctual light architectures and organized paths, for a physical fruition compatible with the characters of the archaeological area. The project approach is shaped around the respect of the needs of conservation and defense of the archaeological heritage, but, at the same time, efficient for the widespread knowledge of historic, archaeological and social characters of these "valuable goods". The support structures have the same generation matrix, modified according to the expected functions; they have been conceived as punctual, light and temporary sustainable architectures, designed according to the main rules of the eco-oriented building.
In this scenery, it is possible to read the signs of a new relationship between technology and archaeological environment.

Keywords: archaeological heritage, technological design, augmented reality

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Introduction (AV)

Culture is the fourth pillar of Sustainable Development, according to a model of development, which ensures the enjoyment of free access to information and widespread communication. Therefore, the Culture becomes the bridge toward social inclusion, environmental balance and economic efficiency, prerequisite for peace and wellbeing[1].

In order to respond to the current challenges of humankind, all government should integrate the cultural dimension in their own policies and strategies of territorial management, establishing concrete actions, oriented to promote consciousness, knowledge and communication of cultural values. So, Cultural Heritage can be considered as the cultural level gauge of a community and, in such capacity, the status of preservation and the knowledge level of this heritage is an indicator of sustainability. In order to adapt the development strategies and policies of the cultural heritage to its preservation, improvement and fruition needs, it is necessary that community could participate to both preservation process and knowledge building.

Preservation and Knowledge are the foundations of the Sustainable Development cultural dimension, meant as cultural heritage complex and integrated protection action, which has been given a value leaving aside the merely economic definition in order to cross the boundaries of history, culture and tradition, coming to be a part of everyday life.

The Early Bronze Age Village of Nola: testimonies of 4000 years ago (GV)

"Campania amounts to one of the most privileged observatory of the rural environment which can be rebuilt in Italy, thanks to a lot of contexts buried during the "flegree" eruptions and, mainly during the Vesuvius eruption of " Pomici in Avellino", which invested a very large area and often sealed the underlying soil" (Albore Livadie, Vecchio, 2005).

The eruption of "Pomici in Avellino" constitutes, together with the most famous one of Pompei and Ercolano in 79 d.C., the most important event in the Vesuvius history. In fact, this event has strongly affected the structure of the involved territory and the development of the settlements and the economy of Campania communities.

"The identification of a cultural *facies* during the Early Bronze Age, the *Palma Campania facies*, which takes its name from the area where happened the first discovery, is certainly one of the most important acquisitions of the archaeological research on the Early Bronze Age in Campania in these last decades" (Albore Livadie, Vecchio, 2005).

The discoveries of the Early Bronze Age Village, at the immediate periphery of Nola, in the Croce del Papa area, near the "Comune di Saviano", started in a totally unexpected way in May 2001, during the works of a contemporary building construction.

The singular discovery in Nola certainly constitutes an important impulse in the area conservation management, in the valorisation of the cultural heritage, and the promotion of the local community identity. In fact, like Pompei, Nola has given back, under a blanket of mud, ash and dust, a context of extraordinary value, which has enormously enriched the cultural heritage in Campania.

The excavating operations, between 2001 and 2002, have firstly interested an area of about 1000 sq.m., slowly extended until just over 1400 sq.m.. At about 6 metres in depth from the surface, the excavations have brought to light in the oriental part of the investigated lot, part of a level village. This last one is made up of a group of huts and annexed structures like roofings and fences, in addition to a large amount of ornaments.

The extraordinary nature of these discoveries in "Croce del Papa" area lies in the perfectly intelligible casts which took their shape after the muddy flood which damaged the settlements, already covered by a consistent layer of ashes and dusts.

So, it has been possible to understand the structure of these constructions, the carpentry, the house and the village organization in the implementation of the everyday activities.

The discovered houses, made up of three huts of different dimensions, and NW-SE oriented, had a horseshoe-shaped planimetric layout, with the entrance in the short wall, probably protected by a dedicated protrusion of the covering layers. The interior is divided in two naves through axial poles in wood which support the two-layer roof, and probably the ridge beam.

The oblique walls were made up of poles, vertically arranged with an axle spacing of about 40 cm and by wooden beams horizontally arranged every 25 cm; all this was covered by plankings of reeds and straw, very probably become waterproof because of further mud layers. Both the poles and the beams were held together by ropes, whose signs are perfectly recognizable in the mud.

In the interior, on the huts sides, there were some vertical trellis, made of interlaced branches, which created with the oblique wall a sort of cavity whose function was that of an air chamber (with a surprising anticipation of the logic that nowadays is at the base of the most innovative technologies of bioclimatic architecture).

As already advanced, huts had very different dimensions: the smallest of mt. 7,50x4,50 x mt. 4,30/4,50 of height, the largest is mt. 15,20x9x about mt. 5 of height, both made up of only two interior rooms; and the longest is mt. 15,60x4,60 x mt. 4,30/4,50 of height.

In the largest hut was probably created a mezzanine floor where you could enter by a wooden rung ladder, of which there are signs near the entrance.

Internally, the huts were divided by wooden partition walls in two or three communicating rooms. The deep apsis area was used as a pantry in which there were big vases full of produces, while the central rooms, in which it was inserted the fireplace, the oven and some ditches (for the garbage collection), were used as living rooms.

Regarding to the settlement, only further and deeper exploratory investigations could supply fundamental data for the understanding of the site typology and to determinate its extension. At current you can only affirm that the three discovered structures were part of a more extended conglomerate which was probably made up of some dozens of residential structures.

Just because of the archaeological richness of this area, ancient environmental scientists continue their analysis and investigations in order to join to an almost complete reconstruction of the larger settlement context. The state of the research, constantly in evolution, allows to mark a significant picture of civilization in these contexts.

The importance of these discoveries, the elaborated data and the revealed archaeological "objects", constitute sufficient reasons so as to transform this area in an Archaeological Park, which can ensure a correct fruition and cognitive diffusion of a such important cultural heritage.

Moreover, the continuous *work in progress* of the works, also suggests the realization on this area of an authentic pre-history and proto-history research center, which could carry out future monitorings on the investigated area for an optimal research orientation.

The extraordinary discovery has pushed the Archaeological Heritage Superintendence of Naples and Caserta to launch a design proposal for a "Pre-historic Archaeological Park" (Fig. 1).

The prosecution of the settlement excavations, the conservation of the findings, and the realization of an Archaeological Park in this area, could constitute, all together, an attraction pole for the international quality tourism, able to generate positive effects on the local economy and the entire area, giving to the Nola City, a positive visibility that only events of this kind can activate.

The Nola Archaeological Park design, involves the Early Bronze Age settlement in the area of "Croce del Papa", placed at about 6 meters in depth under the current soil level. This level is affected by an aquifer present in all the Nolan area.

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The main need is to protect the "good" that, if left in the present state, runs the risk of being consumed by the aquifer, and by the atmospheric agents which strongly affect the discoveries that the volcanic mud coverage has preserved for thousands of years.

So, urgent interventions are:

- to re-bury the excavation, which actually results submerged by the aquifer and so it could be destroyed;
- to create a suitable fruition system which allows an easy use and a total reading of the area regarding the historic-archaeological and volcanic aspects;
- to realize a museum in site;
- to build protection and access equipment and services;
- to develop the "*augmented reality*" for communication and information.
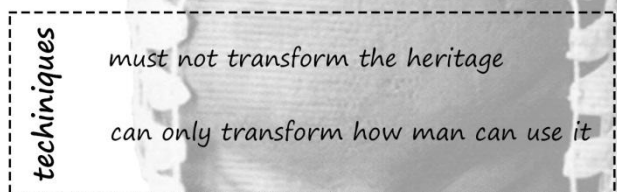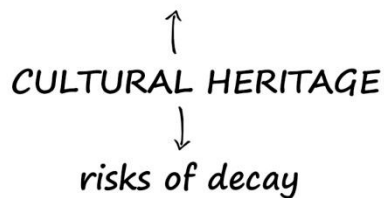

Fig. 1. A design experimentation for the valorization of a singular proto-historic site

Contemporary technological tools for the fruition of archaeological heritage (AV)

The era of digital transformation is a technical revolution that has not spared the cultural heritage sector, rather offers advantages such as: management of a huge volume of data, that can be harnessed for the widespread knowledge; high speed computation of their cultural connections; multimedia control of transformation/valorisation hypothesis and opportunity to protect and preserve from oblivion a rich heritage of knowledge (Zhou et al., 2012).

The environmental resources are shrinking and impoverishing but the flow of information increase. These flows are the new kind of resource, able to start mechanisms of participation and/or multimedia innovative systems, functional to the creation of flows of communication (Fig. 2).
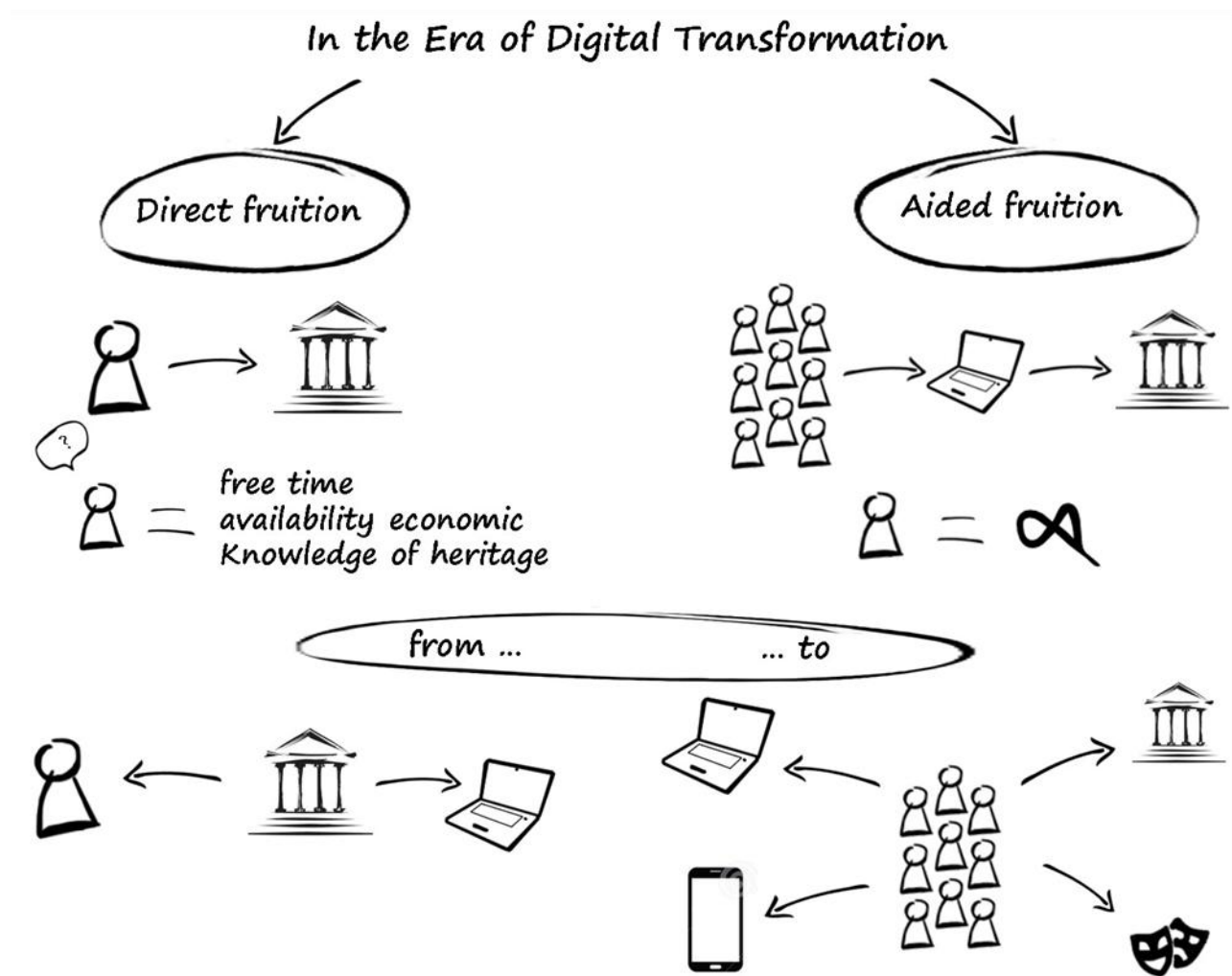

Fig. 2. From direct to aided fruition[2]

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And since "our society is constructed around flows: flows of capital, flows of information, flows of technology, flows of organizational interaction, flows of images, sounds and symbols" [Castells, 2010] the cultural heritage becomes the space of flows. The cultural heritage is not only a physical asset, but has the inherent potential of digital assets. In the network society, flows of communication are global processes, where the categories of space and time are linked with the concept of simultaneity, that is very often associated to that one of hypermobility, in a dualism, where the need of belonging to a global network is flanked to and contrasted by the need not to lose your own local identity (Sassen, 2008). Nurturing knowledge of the cultural heritage and promoting its dissemination is a way to strengthen the identity, historical memory and the sense of belonging. We must not only maintain integrity and performance, but also identity and "acknowledgment". It is no coincidence that "Community and Culture" is one of the indicators of The Sustainable Cities Index, which studied the target sustainability assessment rating of 50 cities in the world[3].

Through knowledge, we are able to define the behavioural patterns, which are at the basis of those interactive processes existing among human beings, from which social phenomena take origin. Knowledge communication processes are filtered through the culture, that can be considered as a system having many dimensions; each one of them is linked to a particular aspect of life, containing the store of information making up our knowledge, but also the behavioural rules and the value systems our society attributes to the wealth of skills, ideas, expertise and experience that, in their turn, give shape to society itself. We must work on the method by internalizing externalities in a virtuous process of learning, which directly involves the user. (Violano, 2005)

Fig. 3. The levels of conceptual fruition of site

The digital transformation aims to convert the end user (generally tourists) from individual consumers to consciously citizen involved and attracted to a more and more qualified cultural material (unmovable and movable heritage) and intangible offer.

Smartphone applications, multimedia guides on touch screen, virtual reconstructions and augmented reality scenarios can have a great historical value in education and science and be a potential opportunity to make attractive the cultural resource for the younger generation. These tools can enhance and improve the hospitality standard of museums and archaeological sites, making the visit a pleasant sensory experience. In particular, the augmented reality increases the perception and user interaction with the environment, providing visual information that the user could not directly detect with their own senses. The real world is virtually enriched with additional graphic and textual information, synchronized and computer-generated (Fig. 3).

The research core is the theoretical study of distributed architectures and intelligent interfaces intended for complex systems as data banks concerning the knowledge of archaeological heritage of Nola, as well as study and designing of open Intelligent Information Systems intended both for virtual domains applications (browsing aid systems, internet interaction and authoring), and for real domains (augmented reality applications).

After recognizing needs and suggesting possible visions, we need to rethink the function by setting the choices on the needs of the users. The project is generally intended to develop and integrate advanced methodologies and techniques for the fruition of the archaeological heritage of Nola, rebuilding virtually the Village of Old Bronze, with its huts and utensils.

The project is the result of the complex typology of the site, which remains without evidences for conservation reasons (technique of preservation: backfilling). The virtual system support to fruition, which is the interface between the user and the good, has the role to play the historic location in the absence of accessible goods.

The network consists of three levels of conceptual uses:
- Research: historical and archaeological data (Target: mainly researchers, academics, specialists, ...)
- Tourism: virtual tour of the village of ancient bronze (Target: tourists, families, …)
- Educational Laboratory: collateral activities connected with the traditions and processes practiced in the village (Target: schoolchildren).
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This differentiated fruition attracts different kinds of visitors: specialists, tourists and students. The research identifies, at a trial-level, a standard path on the archaeological site of Nola, chosen as case study, identifying different reference targets (the student, the researcher, the common tourist, the expert, …) on which creating the offer of specific information. The research aims to identify, according to the different target patterns, the investigation level concerning the information to provide as well as the ways of communication to use in order to meet the knowledge needs of users. The available equipment, thanks to augmented reality, immerses the visitor in scenarios tailored to specific needs. One back slot allows the attachment of iPhone, iPod or Android smartphone, whose screen is transformed into the monitor for the aided fruition.

The democratization of information is real.

Performance approach for the fruitive design of archaeological sites (CF)

"Heritage conservation absolutely depends on long-term sustainability; without it the sites themselves would steadily deteriorate and cease to exist. Interpretation and presentation obviously play an important role in communicating the significance of the sites and their conservation, yet with the increasing use of more expensive and complex digital technologies at cultural heritage sites

interpretation and presentation have themselves often come to represent a significant part of a cultural heritage site's budget" (Silberman, 2009).

In order to prevent an inappropriate use of cultural resources (non-renewable resources), it is important to determine the conditions so that the heritage is not just protected in an institutional way but also in a concrete one. Methodological apparatus capable of defining outcomes that result from the balanced composition of different variables involved must also be prepared. These variables are closely related to the peculiarities of the object to preserve and enjoy.

For several years, an interest in these issues has stimulated me to investigate the critical aspects of the enjoyment in multiple dimensions: the physical one, linked both to the matter and the real visit, as well as the virtual dimension, connected to the sphere of the communication of the heritage. My research has led to the planning of a fruition model characterized by a systemic vision of the archaeological park understood as a "place of complexity" both physical (stratigraphic nature of the archaeological resource; ecosystem balance) and cultural (values, meanings, traditions, ...).

From a methodological point of view, this meant thinking in terms of over - system, divided into the environment (natural and built) upon which the area insists, the spatial context, defined by the set of relations with other local cultural realities as well as the sub - systems composed of the environmental units and the spatial elements of which it is possible to create an archaeological park (accesses, paths, parking areas, media information, etc.). The environmental units have been the subject of a performance redefinition and are the basis of the fruition model in my research called "augmented path" (Frettoloso, 2010). The word "augmented", which has been associated with the concept of use, is clearly derived from computer science and indicates a key aspect of the model: the integration of advanced technologies (virtual reality) as a cognitive support to a direct visit, able to guide the visitor, while making the learning experience of the visit more enjoyable and constructive. In this approach, the users, and their needs, represent the starting point of the valorization strategies, sharing the opinion expressed by Tomas Maldonado (2007: 78) about the role of "direction" that the user can assume with these advanced forms of information and communication technologies.

An application of the "augmented path" methodology

The main aim of the proposed model of fruition is to work on dynamic approaches capable of systematising the numerous variables and, above all, to make some jumps between present and past, real and virtual, object and user.

From a strategic point of view, the project starts from sharing the concept of "integrated fruition", providing two different ways of carrying out the visit: the direct one, conducted on site in contact with the archaeological findings; the indirect one, always carried out on site but through the support of multimedia and virtual tools.

The didactic experience, sharing the systemic approach of the "augmented path", considered the archaeological park of Nola as a structured set defined by specific relationships among the functional areas: presence/absence, proximity/distance, permeability and the hierarchical order among them.

Each functional area is characterized by different performances related, not only to the purpose, but also, to the way of interaction that the user can establish with the archaeological heritage.

The framework of needs related to the users was defined in the meta-design phase. This allowed for the definition of the requirements of the functional areas that comprise the archaeological park according to a criterion of appropriateness that relates the protection requirements of the site, and its context, to the user needs of usability and comfort.

The identification of different types of users has suggested working on the diversification of thematic paths that, according to the methodological premises required the accurate definition of the fruitive strategy through the specification for each area of the way of interaction, real and virtual integration and contents.

In general, the three levels of conceptual uses defined for the archaeological park of Nola can bring together two approaches that refer to different levels of information and interaction: the first, that could be defined immersive, involving virtual reconstructions superimposed on the archaeological findings, allowing for an experience that gives priority to the integration of the real and virtual world; the second, defined according to the different thematic paths, in which the user interacts individually with the information support, ensuring a high customization of information content as well as of the way to interact.

It is interesting to note that this dual approach provides an opportunity to diversify both the visiting regime of the archaeological park as well as the level of physical accessibility of different areas : in the first case , in fact , the number of expected users simultaneously may increase or decrease depending on the whether you assumed an individual interaction (customization of information) or collective (immersive reality); in the second case, instead, it is possible to work according to a "selective approach" to conservation, identifying, according to the needs, which ruins to make physically accessible and which only virtually . The interactive factor, which is necessarily brought in by the support of the information technologies, requires the user to perform a behaviour which should be more dynamic and interested in the surrounding context. This greatest involvement drives the user towards a more conscious approach to the fruition, which can be translated into a sort of re-thinking of the visit, especially in terms of expectations.

In closing there's the "green area" for consideration, the purpose of which is to regain the links with the context. It's important recovering the tie also with the far context, through multisensory experience and a critical reading of the surrounding environment. Working on the perceptive aspects of the communication means not only to look for more immediate ways of interaction but also to widen the public entering there: didactic tools based on the sensory perception which can contribute to improve an "enlarged fruition". Physical and cultural accessibility is one of the requirements that must be met if you want to achieve the quality of the built environment (Garofolo, Conti, 2012).

Technological design to valorize the archaeological heritage in Nola (LM)
In this context, we present a design proposal for the Archaeological Park of Nola aimed, first of all, to guarantee the usability, and to diffuse the knowledge of this astonishing site. The concept design is the integration between the physical and virtual fruition, through the adoption of the most up-to-date communication and information technologies.

The preliminary analysis of all the negative and positive potential factors of the area, has allowed to highlight the main problems and to elaborate the design proposals for the solution of these critical situations. The main objective is to protect the archaeological good and, simultaneously, to realize a fruition system, structured in different paths according to the different types of users. The support structures have been conceived punctual and light, eco-friendly and energetically efficient, in order to avoid that in the park they could be dominating, in terms of both extension and impact. The tours, the "open air" space, the educational and scientific research laboratories, are all elements which have been created and designed (because of the configuration and the materials choice) according to the fundamental principles of the eco-oriented building: collocation, orientation and form; natural

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ventilation; use of eco-friendly materials and renewable energy sources; recovery and reuse of rainwater.

In brief, the principal "actions" of the design proposal are:

1. The re-bury of Archaeological asset, and the reconstruction *in situ* of a model on scale, to guarantee the protection of the original good but, at the same time, to guarantee its visibility to the users;
2. Realization of a suitable physical and virtual fruition system of the site;
3. Construction of a system with punctual structures to contain the park services, equipments and tools: museum, laboratories, bookshops, info points, green area (Fig. 4);
4. Development of "Augmented Reality" technologies for the communication, the information and the valorization of the historic-artistic heritage, *in situ* or on-line.
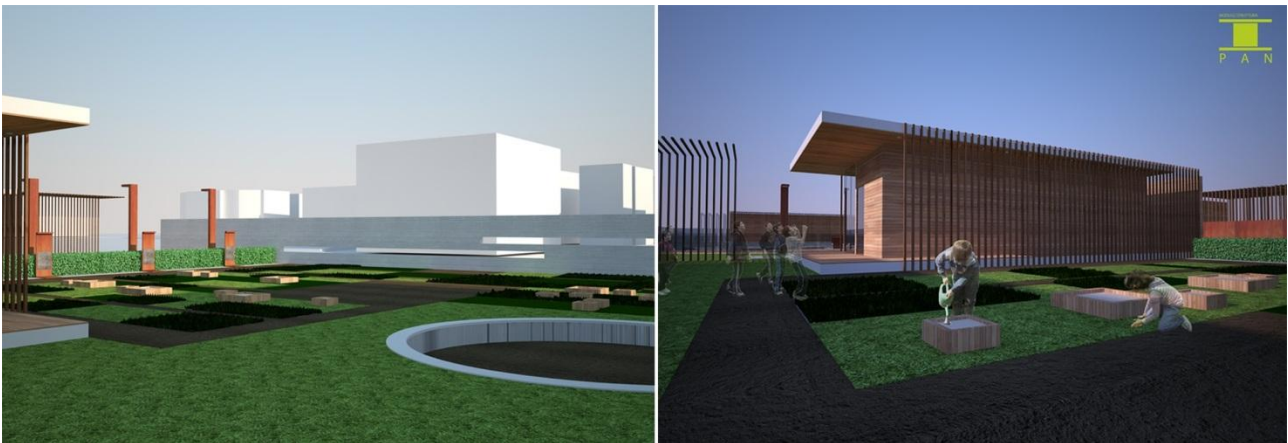

Fig. 4. The Green area: an experimental vegetable garden

The singularity and the originality of the discovery have employed the technicians of the Archaeological Heritage Superintendence of Naples and Caserta, in the research of both new excavation methods and innovative recovery, survey and conservation techniques.

The techniques and the materials used for the re-bury, typical of the "underwater archeology", have been chosen according to the conservation needs of the archaeological structures left *in loco*. Moreover, it has been suggested the reconstruction *in situ* of an on scale model of one of the three discovered huts to let understand, through the direct observation, information regarding the building techniques and the used materials of the epoch.

Besides the principal objective of the project, that is the protection of the good, there is the valorization of it. To reach this goal, it has been studied, for the PAN, a fruition model which systematizes the needs of the different type of users (generic tourists, specialists, children), and the purpose of the cultural valorization of the good, transforming the site in a big box of functions and connections.

The park system is divided in four main functional areas:

- entrance-collect area;
- educational and recreational area;
- services area;
- Museum area (Fig. 7).

All these areas are inter-connected by a thematic paths system, equipped with dedicated signage, and diversified according to the users' categories.

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The fruition system is developed in five paths (obliged, free, green, for experts and exit paths), of which the first two are realized with a flooring in teak wood staves and parapets in Cor-Ten steel, while the others, in recycled plastic material. (Fig. 5)

Fig. 5. The fruition system

The architectural design of the closed spaces is based on the principles of flexibility in the light of the on-going context of the research, the intervention reversibility and the work recognizability, absolutely not mimetic. [Melchiorre, 2013]

These architectural modules, conceived with a prefabricated structure in wood, brushed aluminium and glass, have the same generating matrix, conveniently modified according to the use needs of the different destinations.

The eco-oriented design has allowed to minimize the impact of these constructions on the environment in a concrete manner.

To the purpose of an optimal location of these buildings, it has been carried out the sun shadow and ventilation study, both in winter and summer conditions, through the software Ecotect Analysis. For the different modules, it has been guaranteed a direct caption of the solar rays, used in the winter season to maximize the heat supply in the interior space, thanks to the adoption of low-emission

glasses, and shaded, instead, during the summer season, so as to reduce the heat charge in the buildings. (Fig. 6)

The energy supply of these constructions, instead, is guaranteed through the installation of an integrated photovoltaic system in thin film of amorphous silicon, which easily adapts to the plain covering of the blocks in the area.

To the purpose of the energy containment, particular attention has been given to the structures envelope (walls, floors and transparent envelope), for which through a correct technological design, controlled by the software *Termus*, and the choice of suitable materials, it has been possible to obtain values of transmittance, phase shift and attenuation, contained within the values provided by the Decree No. 311/2006.

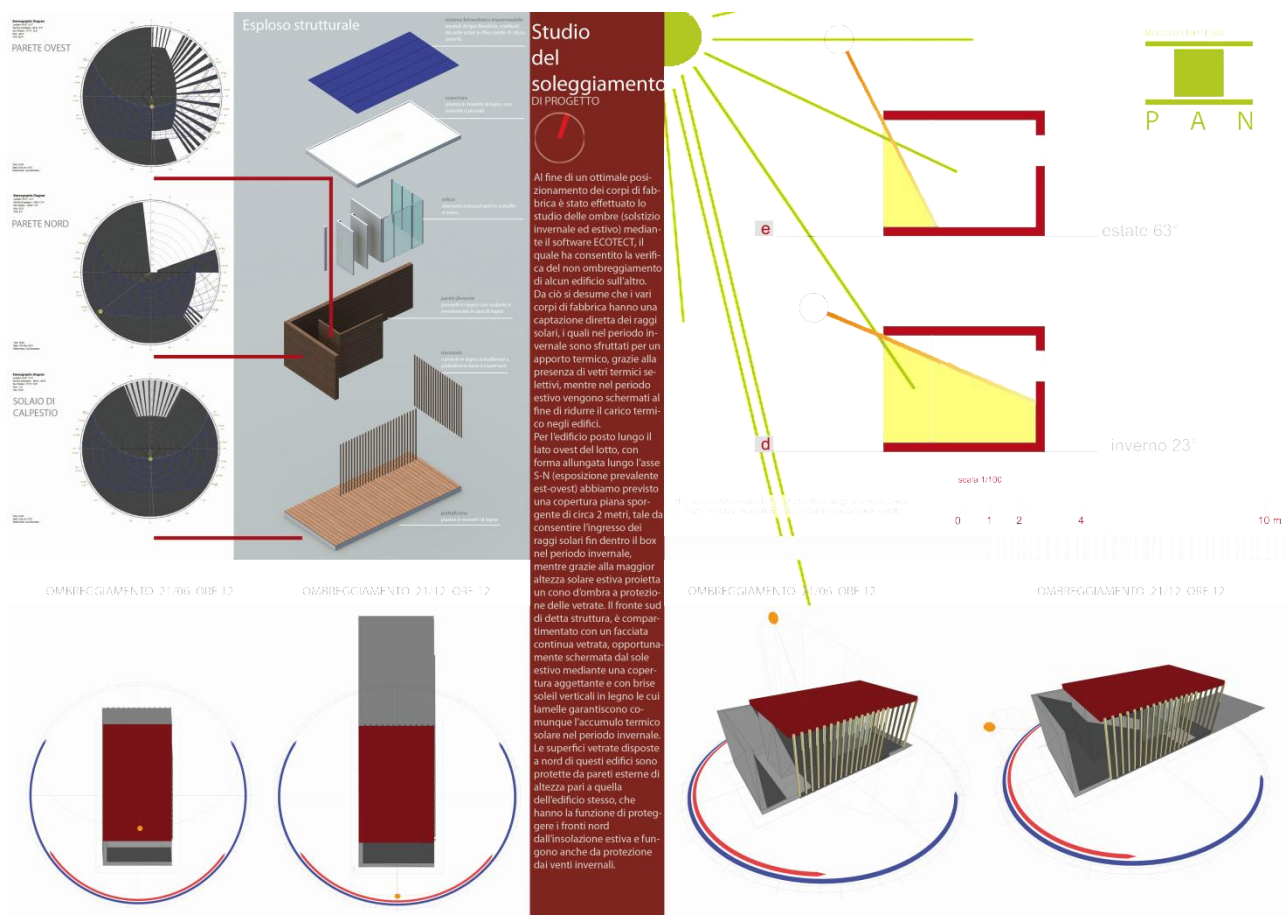To obtain this result each partition was examined individually.

Fig. 6. Technological design of ticket structure.

The main function of an archaeological site, in its relationship between the exposed content and the equipment, must aim for both the conservation and the knowledge in order to fulfil the goal of communication and divulgation.

Different types of fruition have been taken into consideration and realized according to the different informative supports employed. The systematization of these data has opened interesting sceneries, which have suggested to move towards innovative fruition modalities, arriving at the idea of realizing an AR instrument able to support tourists in the area.

Tablets, smartphones, and personal computers acquire the double role of virtual guide – through the reconstruction of structure and characters who have left a sign on the territory – and real guide – during the direct tour of the places – giving useful information about the itineraries and the fruition modalities.

This research has highlighted the existence of numerous projects related to the development and the application of reality increased in the archaeological sites. Starting from the analyzed projects, it has been hypothesized the development for the PAN too of an AR app called "Back to Nola".

This system aims to the reconstruction and the animations, through the AR, of daily life scenes of the village to be "shown" in reality. This AR system opens to the visitor a virtual window (through smartphones and tablets) on the past, allowing his interaction in real time with the reconstructions of the village.

The project gives the possibility to select paths according to the themes or to the duration, and of being addressed towards the indicated points of interest: text, photographic and audio material.

The project can allow the fruition both through mobile devices and the internet.

Fig. 7. The Archaeological Park of Nola: Museum.

Conclusions

There was a time when art and technology appeared to the opposite poles of the culture. In the last years the things have changed a lot. We're not talking about the digital arts, but about the way fruition experience has changed.

The issue of the contemporary fruition of Archaeological Heritage, has been analysed from different points of view. The research goal is to highlight the opportunities in terms of experimentation related to the conservative approach, with a particular attention to the role of multimedia and virtual technologies.

The proposed design is based on a methodological approach that systematizes user needs and requirements of information tools. From this starting point, the illustrated design, was created through the integration of innovative technologies and a particular attention to bioclimatic design rules, that represents the added value of the project.

Therefore, the experimentation design, showed as the adoption of technological innovation and process, represents an essential tool for the sustainable management of cultural heritage.

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[1] Cfr. UNESCO's Universal Declaration on Cultural Diversity (2001).

[2] Picture of Pierfrancesco Iodice.

[3] Cfr. Arcadis, Sustainable Cities Index, 2015. Balancing the economic, social and environmental needs of the world's leading cities.