

Universal Design and Interoperable Digital Platforms Between Conservation and New Fruition Opportunities. The Case Study of Arianna's Domus in Pompeii

Renata PICONE

Department of Architecture | University of Naples "Federico II"

Abstract. The paper aims to examine the last results of experimental and interdisciplinary research, started in the archaeological area in Pompeii by the "Federico II" University in 2010, on the enlarged fruition in Pompeii. After Covid-19 pandemic is necessary to rethink the use of the archaeological site considering the need put in place by the health emergency, combining instances of a perception of the archaeological heritage in safety with those of a direct and indirect experience, rationalized and increased thanks to the Universal Design and the use of new interoperable technologies. The increase of knowledge, the survey, and the digitalization of the acquisition processes, by developing optimized methodologies for integrated surveying and modeling for the Heritage Building Information Modeling (H-BIM) and for the archiving and management of data relating to the heritage, facilitate the sharing of cognitive elements starting from new methodologies and processes of knowledge. The searches, in line with the themes of the Universal Design and thanks to an interoperable web-based platform, experiment technological devices for the accessibility in relationship with the changed needs of cultural fruition due to the pandemic. A special focus analyse on how the conscious use of new technologies may be the key to understand the material and immaterial traces of the case study: Arianna's domus, in the Regio VII, Insula IV.

Keywords. cultural heritage, accessibility, Pompeii, digital, HBIM

1. Introduction

This paper presents the first results of the research "CHEAC. Cultural Heritage After Covid. Interoperable Pompeii", funded by the Italian Ministry of Universities and Research, based on the institutional collaboration between University of Naples Federico II, Polytechnic of Milan, and National Research Council (CNR). The research aimed to create a digital web-based platform for the monitoring and conservation of archaeological evidence and for the definition of new ways of use because of the possibilities and limits of cultural participation imposed by the pandemic. The use of digital technologies has a dual convenience. The platform, built according to the principles of H-BIM (Heritage Building Information Modeling), in fact, allows the "manager" the digitalization of the processes of control of flows and risks and it make more comprehensible and comprehensive educational content related to cultural heritage for the "user".

According to the principles of the Universal Design, in addition, the web-based platform allows quick access and easy interpretation of information, increasing the level

of fruition for the visitor in terms of flexibility, simplicity and perception (UD's 2nd, 3rd, 4th principles).

In this way, the platform promotes the monitoring of archaeological evidence, and his open spaces and feeds processes of Facility Management and new practices of active participation by any type of user (equity, UD's 1st principle). The web-based digital platform allows with absolute ease to share information, both managerial and informative, meeting the recent need to increase the standard of control and reception of archaeological parks. These entities represent the places of greatest interest as regards the topic of the decongestion of visitor flows in the most frequented areas, as well as the seasonal adjustment and diversification of the tour routes. It's useful also for a containment of physical effort (UD's 6th principle) and to make the spaces suitable for access and use (UD's 7th principle). Characterized by an "urban" dimension, in fact, the archaeological park requires innovative tools for new management strategies and an operational speed that can be supported only by the modern information technology.

For the first phase of experimentation of the web-based platform, we chose the case study of Arianna's Domus, whose critical issues were identified, both from the point of view of degradation and the use of the domus. The knowledge phase was based on the cross between the direct funds, archival documents also unpublished and bibliography available, with the relief using drones and 3D laser scanners. This comparative reading made it possible to reconstruct the domus's phases and the excavations and restorations that involved it over time, graphicized by photogrammetry and restitution software.

The next phase, combining all the data and information outcome of the cognitive phase, saw the realization by the company Acca Software, an H-BIM model that reports elements categorized according to their function. Each element can be inspected and refers to dimensional data, material and status of storage appropriately classified by technical data sheets readily available on the platform. The last phase of the research involved the drafting of a prototype maintenance sheet to indicate the interventions to be carried out *in situ* and the chrono-program of the maintenance activities. Moreover, from the point of view of accessibility, the analysis of internal flows for operators and the immediate availability of information for visitors, improves the fruition of the domus, increasing its cultural interest and ensuring its transmission to the future.



Figure 1. Location of the Arianna's domus in the Archaeological Park of Pompeii

2. Typological analysis. Excavation and restoration: historical values for an inclusive fruition

The Arianna's domus is one of the largest houses within the Archaeological Park of Pompeii, located in the Regio VII, Insula IV, with its 1700 m² of surface. This domus has two accesses, one on "Via della Fortuna" and another on "Via degli Augustali", occupying the North-South side of the Insula. The Regio VII, which includes the Arianna's domus, includes the area between the Civil Forum and most of the residential blocks located near the roads of "Vicolo dei Soprastanti", "Via Augustali" and "Vico Lupanare".

These residential blocks make it necessary, because of their position and spatial complexity, new systems of orientation and visit. It is, in fact, an area developed independently from the rest of the city for the orography, complicated by the inclusion in the urban complex of two religious and public areas: the Tèmenos of Apollo and the Forum Square. In the imperial age the area was equipped with shops, refreshment point and thermal baths, such as the Stabiane Baths and the Forum Baths.

Probably, in 79 AD, at the time of the eruption of Vesuvius, the Arianna's domus, also known as the House of Colourful Capitals, included about seventy rooms on the ground floor, organized around three areas of distribution: the atrium, the central peristyle and the northern peristyle. This typological and morphological complexity, enriched by the presence of sculptural apparatuses and precious frescoed surfaces, has made the Arianna's domus the ideal case study for digital systemization through an interoperable web-based platform.

Arianna's domus is also located along the path "Pompeii for all", inaugurated by the Archaeological Park of Pompeii in December 2017. This project has already eliminated the physical architectural barriers and solved the differences in levels inside the domus by stabilizing the beaten and vegetable paths (armed lawn).



Figure 2-3. On the left: Painting of the Casa dei Capitelli colorati (VII 4, 31), Fausto and Felice Niccolini, published in "Le case e i monumenti di Pompei", 4 vols., 1854-1896. On the right: Marco De Gregorio (1829-1876), La casa dei capitelli colorati, oil on canvas, cm. 47,6 x 38

From recent excavations (2004) the Arianna's domus is built in its entirety around 150-130 BC, occupying pre-existing structures dating back to the second century AC. Further changes to the domus date back to the Imperial era, as evidenced by the archaeological traces that emerged from the excavation.

Around the first century AC. the Arianna's domus underwent important planimetric and functional transformations. In addition, the state of "construction site" of the domus

at the time of the eruption of 79 AD, suggests significant changes in terms of entrances and the main directions of fruition and use of the villa. The hierarchies of the atria were probably overthrown and the rooms in front of the central peristyle were enlarged and redecorated. Despite the architectural changes carried out in the recent phase, the Arianna's domus is tripartite and with each of the parts developed around a void: corinthian atrium, central peristyle, tuscanic atrium. Each of these follows, in the arrangement of the environments, specific rules that make them formally autonomous but, at the same time, the three parts are put in relation to each other according to clear geometric/perspective rules. The formal order of Arianna's domus develops in a centripetal manner: the two atria are arranged on a street opposite the block and orient the respective rooms towards the central peristyle, making this place the fulcrum of the entire composition.

A single longitudinal perspective axis allows you to view the domus in all its extension from the *fauces* of "Via della Fortuna" to those of "Via degli Augustali", passing through the geometric centers of the *tablini*. This axis, from the centre of the peristyle, undergoes a perspective correction of some degree, to align with the sequence of the colonnades.

The excavations, which covered the entire area of the Regio VII, were started around 1827. In 1833, after six years of activity, the Arianna's domus was dug up, so called at the time for a painting that was found in one of the rooms, namely the *Oecus*. The domus, as can be deduced from the excavation papers, presented only small remnants of what it really had to contain, but was considered from the beginning to be among the most important of Pompeii. It was the expeditious and careless method of excavation that caused the loss of much of the surviving material.

The first restorations, carried out after these excavations, date back to the second half of the nineteenth century and provided for the construction of wooden roofs and brick tiles and the replacement of the existing lintels, now dilapidated.

In the twentieth century further restoration work was carried out: in 1950, under the direction of Amedeo Maiuri, support props were inserted in some points of the roof; In 1970, with Alfonso De Franciscis, the nineteenth-century roofs were further modernized with iron structural inserts and polycarbonate elements.

The most recent restoration works date back to 2014 and have further updated the previous restorations, replacing the polycarbonate cover with a false roof plate.

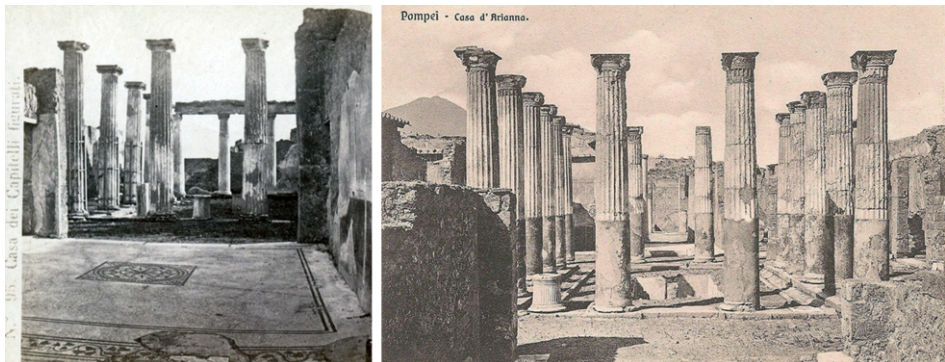


Figure 4-5. On the left: Pompeii. Stereoview by R. Rive, c.1860-1870s. Looking south across tablinum towards peristyle, showing original mosaic floor and decorated west wall. On the right: Pompeii, Naples. Arianna's domus, original photo with albumin, Brogi, c. 1880.

The degradation of a building is related to the aspects of technological and material conservation, to the problems of structural instability and to the resilience of the building structure. Through the analysis of the fissured picture, an integral part of the knowledge phase, it has been possible to identify the main phenomena of instability in progress, to understand and schematize them.

There are phenomena of crushing of the masonry, disintegration of the wall ridges and overturning of the columns. The crushing phenomenon includes among its causes the weight of the roofs and the restoration lintels, the antiquity of the materials and the poor quality of the mortars, generating as an effect the disintegration of the mortars, the detachment of plaster and peak load injuries. The disintegration of the wall ridges is generated by the absence of protective cases, infiltrations of meteoric water and cycles of frost and thaw, causing cracking phenomena and attack of autotrophic organisms.

Regarding the column system, the absence of connecting elements, the antiquity of the materials and the alteration of the trilithic system have generated as an effect the overturning of the isolated elements and the detachment of material. The decorated wall and floor systems are in a very poor state of preservation, this is due, basically, to the absence of protective elements and the lack of cyclical maintenance interventions. Almost all the wall systems have discoloration, which makes it difficult to interpret the decorations, surface deposits and lesions that lead the frescoes to detach from the wall support. For the floors, phenomena of biological patina, detachment of mosaic tiles and surface deposit have been found. These critical issues have been duly recorded and included within the BIM model, to interpret over time, the evolution of degradation. In addition, to combat degradation and prevent the loss of material, maintenance sheets have been developed in which, after a diagnosis phase, possible ways of cleaning, consolidation, protection, and maintenance are identified.

3. Technological and physical tools for accessibility. The H-BIM model and the web-based platform for the Arianna's domus

The prototype of the “enabling digital platform”, the object of the project, is characterized as a web-based software solution. It is aimed at knowledge, restoration, Universal Design, new opportunities for use, management, and security of the archaeological site. The aim is to define a digital ecosystem of cultural heritage that can reconnect all the actors involved in the expected processes, enabling the exchange of information, including the public, through digital information modeling technologies.



Figure 6. The result model of processing the dense cloud, after the Domus relief with 3d laser scanner.

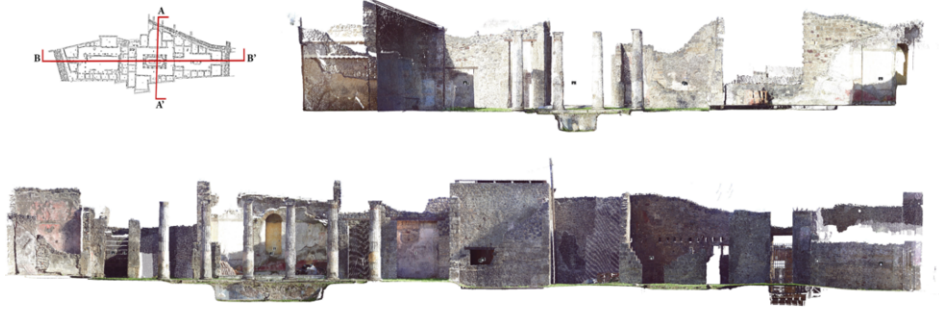


Figure 7. Two sections of the Domus, one longitudinal and one transverse, obtained from dense cloud with coordinated software.

The design idea proposes the use of the BIM management platform usBIM.platform, developed and marketed by ACCA Software S.p.A., IFC certified by building smart international.

The CHEAC project, as mentioned, focused on the Archaeological Park of Pompeii and specifically on the case study of the Pompeian Domus of Arianna. It is used to test the digitalization of the processes of reading, acquisition, storage, and management of data relating to the archaeological heritage, adopting optimized methodologies of integrated survey and modeling for the Heritage Building Information Modelling (H-BIM).

The project activities began with several inspections at the Arianna's Domus, of which an architectural survey was carried out using drones and 3D laser scanners. Obtained about thirty dense cloud - defined as a set of points referenced in space, containing information of both geometric and colorimetric character - the BIM model of an example part of the case study was generated, useful to the goal of the project, thanks to scan-to-BIM processes using BIM Authoring software from ACCA software "Edificius".

This operation has cross-checked the data of the material analysis and the critical conservative relative to the degradation of the archaeological evidence, with the help of the application of orthophotos on the digital model BIM. This way of creating the model has made it possible to digitize and share all the data collected during the field survey operations, easily accessible from the BIM model from anywhere and through any device, operating only via web-based browser. The model, equipped with textured 3D meshes, 360° panoramic photos, graphic tables, and text documents, thus optimizes the processes of acquisition, storage and management of data relating to the archaeological heritage. The platform also allows you to create tags, links and geo-references of information, documents and/or images, and it can be quickly consulted both by Pompeii technicians for monitoring and maintenance, and by visitors to guide the visit and storytelling.

In addition to the presence of valuable structural, architectural, and decorative elements, the platform can also signal to the visitor stepless entrances, non-slip surfaces, manoeuvring spaces, points of greater visibility, presence of audio-visual tools, Braille maps, qr-codes to web pages that provide alternative text to describe the images, etc.

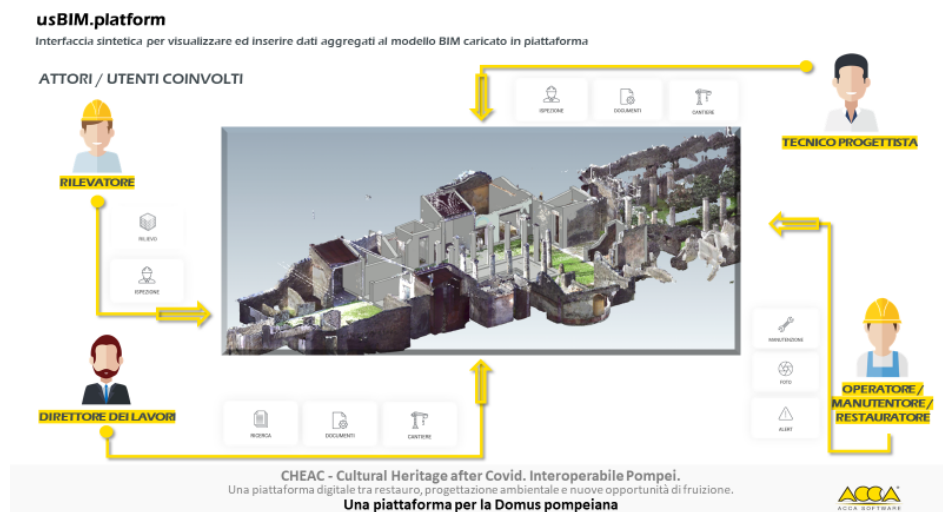


Figure 8. usBIM.platform: definition of web user interface, potential actors/users involved

The platform, through a customized interface to the user who operationally intervenes in the real on the archaeological good, can certainly act as a support to the digitization of the operational processes of the Archaeological Park of Pompeii. It can provide a set of innovative digital services. These potentials guarantee data security and reliability, interoperability of functions and accessibility of services by all the different actors/users involved.

4. Conclusions

The project “CHEAC. Cultural Heritage After Covid. Interoperable Pompeii” has created a first version of “digital platform enabling” web-based knowledge, restoration, environmental redevelopment, use, management, and security of the Arianna’s domus, adaptable to the entire site of Pompeii and exportable in other archaeological complexes. A digital ecosystem has been created that connects all the actors involved in the preventive and conservative process (architects, engineers, archaeologists, restorers, etc.), enabling the exchange of management information, and the public, through digital technologies of informative modelling for the communication of updated contents.

The potential offered using HBIM for the entire management of conservative interventions to be performed (prevention, maintenance, restoration) allow to operate in a three-dimensional system also useful for the management and simulation of internal flows, today only two-dimensional (SmartPompei platform). From an operational point of view, in fact, the platform promotes and facilitates the knowledge, restoration, environmental redevelopment and safety of the archaeological site, ensuring above all the use in complete safety. It represents a real collaborative network, hosting a large amount of information, data, and statistics that, outcome of the work of professionals and technicians of different fields and disciplines, allow a critical interpretation of all the factors involved in the processes of monitoring and maintenance of archaeological artifacts, based on a complete historical-morphological knowledge. This synergy, facilitated by interoperability and rapid consultation, reduces the probability of failure or

malfunction, monitors the status of archaeological artifacts, and allows the programming of maintenance works, to be performed at predetermined intervals. Similarly, the large amount of information, always updated and related to the morphological and historical dimension of the site, promotes the understanding of the artifacts, and increases the awareness of users. They, according to their interests or inclinations, can select the contents, choosing various and different modes of storytelling and oriented fruition.

Moreover, the searches experiment, according to the themes of the Universal Design and thanks to the interoperable digital platform, technological and “physical” devices for the accessibility in relationship with the changed needs of cultural fruition due to the pandemic.

In Italian post-Covid scenarios a first focus seems to relate the territory on which it is expected to implement a set of programmatic lines no longer deferrable (de-congesting, de-localizing, de-centering, de-seasonalizing, diversifying). Assuming a rich domus as case study, a possible strategy is proposed to apply the “five-d” in Pompeii for the conservation of archaeological rests and a new fruition of tourist flows.

In this vision, innovative technologies allow:

- 1) new practices of active participation, with equity, flexibility, and perceptibility.
- 2) a broader understanding of the educational contents associated to the cultural heritage.
- 3) the digitalization of flow control processes can minimize risks or unwanted actions.
- 4) the equipment of the open spaces can make the space suitable for access and use.
- 5) the implementation of Facility Management processes.

The combined application of the principles of Universal Design and the use of an interoperable digital platform leads to the improvement of accessibility by all in compliance with the safety standards required in the post-Covid period for users (social distancing, remote use for some contents, provision of alternative visit scenarios, immersive reconstructions) and for the archaeological heritage (control, monitoring and prevention; real-time diagnostics, forecasting of future conservation scenarios).

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