

METHODOLOGY OF DIGITAL SURVEY FOR THE DOCUMENTATION OF THE ARCHEOLOGICAL HERITAGE, THREE PROJECTS FOR UNESCO WORLD HERITAGE SITES: VILLA ADRIANA IN TIVOLI (ROME), THE FORTRESS OF MASADA (ISRAEL) AND THE BASILICA OF THE NATIVITY IN BETHLEHEM (PALESTINE).

METODOLOGIE DI RILIEVO DIGITALE PER LA DOCUMENTAZIONE DEL PATRIMONIO ARCHEOLOGICO, TRE PROGETTI PER IL PATRIMONIO MONDIALE UNESCO: VILLA ADRIANA A TIVOLI (ROMA), LA FORTEZZA DI MASADA (ISRAELE), LA BASILICA DELLA NATIVITÀ A BETLEMME (PALESTINA).

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ABSTRACT

New media and digital tools offer us the possibility to experience, as visitors, travellers or even as resident, 3D virtually reconstructed historic sites. Many critics have identified different issues that often inhibit widespread distribution and use of virtual heritage.

This paper through some examples of three UNESCO World Heritage archaeological sites, Villa Adriana in Tivoli (Rome), the Fortress of Masada (Israel) and the Basilica of the Nativity in Bethlehem (Palestine), tries to show and analyze, even critically, some of the different methodologies and investigation strategies at our disposal for the construction of equipment documentaries and surveys also aimed to the virtual reconstruction of the archaeological heritage.

Keywords

Archaeological survey, Digital survey, 3D laser scanning, Virtual reconstruction.

PREFACE

In order to take advantage of the cultural heritage resources it is necessary to think strategically about their future development and create a digital space where many typologies of users, cultural operators, architects and others people involved in the scientific research can connect together through exchanging and filing data. To play a leading role in the production of content, in the field of protection and documentation of Cultural Heritage Sites in the age of digital innovation, it is important that institutions like universities offer themselves as an “agora” where can meet tradition, scientific and technological development and find ways for contemporary dialogue.

The possibilities of media devices allows the users to select different levels of detail, to customize the paths of knowledge, to foster dialogue with contemporary contexts in the rest of the world, thus breaking down geographical barriers and cultural and linguistic diversity. In practice, this is achieved by designing content and related communication strategies that identify the languages and the most appropriate tools to interact with the different information requirements, idioms spoken and the dynamics of interaction with each type of audience. When man plans 3D survey and documentation campaigns for archaeological sites and urban settlements, the relationship between tangible and intangible heritage is definitely a complex issue to solve. The relevance of these relationships was recognized by UNESCO as early as 1964, in the Venice Charter, which stated that “A monument is inseparable from the history to which it bears witness and from the setting in which it occurs” (Art. 7). But the realization of a suitable design process is far beyond having been accomplished.

The continuous evolution of techniques for surveying and 3D modeling based on the sensors and the development of ever more efficient systems for displaying digital data highlighted the added value from the use of these methods in the context of architectural documentation. The technological solutions available nowadays at disposal of the architectural survey offer numerous opportunities for conducting documentation projects in the field of Cultural Heritage, both as regards the time of primary survey, or rather the phase of metric data acquisition, and as regards the question of representation for objects of archaeological, artistic and architectural interest. It is an integrated and multi-disciplinary approach of techniques and technologies that make up many different approaches to determine the multi-scale surveys, which place a phenomenon in relation with its context, where all the datas and results of a survey converge into a single and well defined reference system.

The digital techniques and technologies offer the possibility of obtaining new products not only from survey activities, but also in the representation and in the visual field; with the purpose of having a accurate metric description of the architecture, structures and artefacts they constitute powerful

instruments for the analysis of objects in support to the conservation and restoration.

The acquisition and the processing of data must be made following appropriate methods, taking into consideration the characteristics of each technique both in terms of inherent capabilities, such as accuracy and format of the data, and for the purpose of mutual integration, with the aim to incorporate all the products in a common database, useful for many applications. This paper through some examples of three UNESCO World Heritage archaeological sites, tries to show and analyze, even critically, some of the different methodologies and investigation strategies at our disposal for the construction of equipment documentaries and surveys also aimed to the virtual reconstruction of the archaeological heritage (cfr. Bertocci, S., Parrinello, S., 2015).

VILLA ADRIANA IN TIVOLI (ROME)



Fig.1 Villa Adriana: general plan and views from the 3D point cloud

The project "The documentation of Villa Adriana in Tivoli: digital survey to the conservation and enhancement of archaeological sites" began with some survey campaigns conducted by the Department of Architecture of the University of Florence. The Hadrian's Villa, near Tivoli (Rome), was constructed between 118 and 138 C.E. by Emperor Hadrian over an area of 120 hectares and has been declared a World Heritage Site by UNESCO in 1999.

The digital survey campaign focuses on three areas of the great Imperial mansion: the so-called Area di Palazzo, the Courtyard of the Libraries and the Maritime Theatre. Topographic and 3D laser scanner devices, together with photo modeling applications based on Structure From Motion, has provided to the research team a uniform framework for the documentation of the archaeological area of the villa at different levels of detail.



Fig.2 2D drawings and orthophotos from the digital survey of Villa Adriana



Fig.3 Virtual reconstruction of the archeological area of Villa Adriana

The project, begun since 2010, involved later three universities, Florence, Pavia and Bologna, in collaboration with the Superintendence for Archaeological Heritage of Lazio, for the purpose of the digital documentation of the Villa Adriana archaeological site.

The objectives of this collaboration are to create a comprehensive digital documentation of the existing site, to contribute to the drafting of the UNESCO management plan and to create a database that will serve as a base cultural resource management tool for the further historic documentation and conservation and restoration activities.

It was decided not to create a unique model to maintain a high level of detail of the model itself. All the models were then grouped by broad groups, environments and construction bodies, always using the classification identified by Guidobaldi (Guidobaldi, F., et al., 1994, Adembri B., 2000). The mesh models so made have been optimized with a software of reverse modeling and they have been remapped into the photogrammetric software. The models thus generated were imported into a software of rendering where we added lighting. For verification, we compared the individual macro-photogrammetric products with the corresponding models from laser scanner data and we got a standard deviation of 2.2 cm thus verifying the high reliability of the product. In order to provide useful information on the web to view this area of Villa Adriana it has been suggested a platform where any user, visitor or researcher, can see all the work produced according to his own interests.

FORTRESS OF MASADA (ISRAEL)

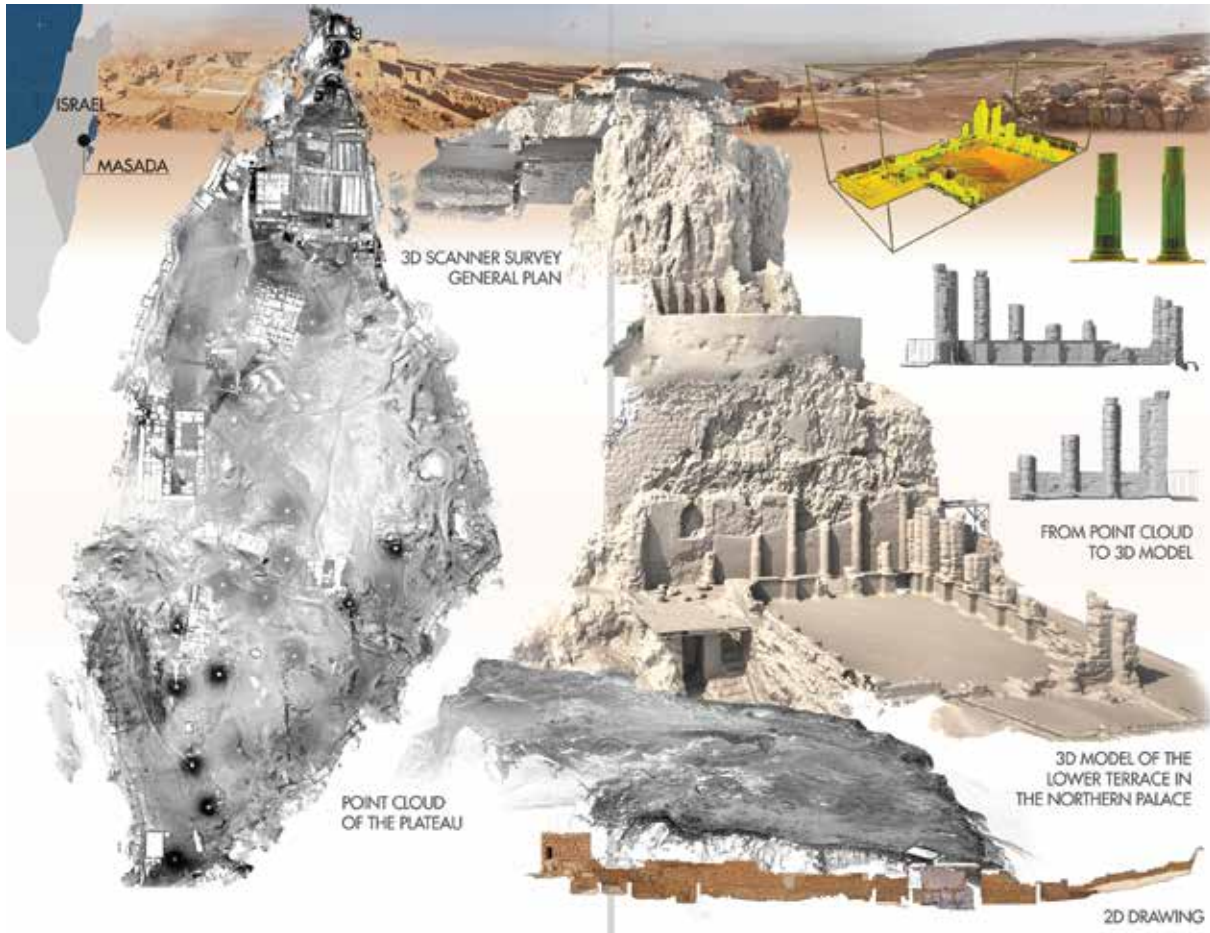


Fig.4 3D point cloud and 3D models of Masada's Plateau

The site's history is documented in particular by the Roman historian Titus Flavius Josephus, who describes the fortress of Masada, used as a fortification from the second century B.C., situated on an isolated mountain with steep rocky slopes with only two accesses (Vitucci, G. 2012).

On top of the hill, at a height of about four hundred meters above the Dead Sea depression, there is a flatland of an area of about ten hectares. This summit plateau is fenced in by a curtain wall that extends for about 1,300 meters, and it is made of a double wall, with a first outer curtain wall with the reinforcement of towers and with an interior wall. The two walls are connected by transverse walls that form a series of communicating compartments (called casemate system), once used as warehouses, arsenals as well as residences. Among these spaces there is also a synagogue (considered one of the most ancient of Palestine), and some buildings used as columbaria.

Inside the fortified wall, in the northern area, there is an well-structured complex, the Palace: the storehouses, made up of two series of buildings with long rooms (from 20 to 27 meters) and inner road network, the wide residences with inner courtyards, including the so-called Herod's Palace dating back to the first century BC. It is an amazing monumental complex located on three terraces of the rocky summit over the desert and with the beautiful panorama of the Dead Sea. Within the complex there is also a big thermal palace opened on a courtyard with swimming pool and cisterns.

Well-preserved also the ruins of the great structures for the siege of Masada, built by the Romans between 72 and 73 AC, consisting of a wall surrounding the hill, reinforced by the presence of eight military camps, fortified with the traditional quadrilateral plan structure.

Among the siege structures the most impressive remain is the artificial ramp, made of earth and protected with wooden structures (some traces still existing), used as sloping plane to reach the walls on the hilltop with an huge siege tower celebrated in the writings by Josephus Flavius.

For the study of archaeological sites, such as the site of Masada, the use of different survey methods such as laser scanner survey (carried out by two distinct equipments), topographic survey using GPS, three-dimensional modeling of the fast-type survey through processing of panoramic pictures 360 ° and documentation activities generally through creation of panoramic pictures, produced a large amount of material and information, then the use of systems of archiving with encodings programmed incoming data is crucial for the result then operate in an orderly manner in the stages of postproduction and elaboration of the final data.

THE BASILICA OF THE NATIVITY BETHLEHEM (PALESTINE)

The Basilica of the Nativity is one of the oldest Christian churches, built around 330 on the initiative of Emperor Constantine I and his mother Elena on the ruins of a pagan temple built in the period of Hadrian, on the places where the early Christians celebrated the birth of Jesus.

The church was restored and enlarged in the sixth century by Emperor Justinian I. The complex has undergone several expansions and modifications both in the Crusader period than in later centuries, presenting today as a complex system of volumes and structures that is divided in the Franciscan monastery, the Orthodox monastery and the Armenian monastery, located around the walls of the basilica (Pixner, B., 2010; Bagatti, B., 1952). In 2010 considering the needs of restoring the covers, the trussed roof, the wall surfaces, and the mosaics, following an international tender the preliminary study of the monument was assigned to a multidisciplinary team coordinated by Ferrara Research Consortium (University

of Ferrara), with the aim of drawing up the restoration project. In 2013 the Palestinian government, under the supervision of universities team, has promoted the restoration whose execution of the work was assigned to the company Piacenti SPA. The same company has indeed entrusted the Joint Laboratory Landscape Survey & Design of University of Florence and University of Pavia, for the analysis and new digital surveys of the construction site during the restoration work from 2014 and still in progress. The project involves testing for 3D laser scanner data capture, the development of detailed architectural drawings of architectural structures and wall surfaces, and the creation of three-dimensional models aimed at documentation of the restoration and development of instruments for the promotion of the complex. It is very important to determine the architectural image, the materials and quality of the masonry of each lived environment, through the execution of a drawing allowed to order, in a physiological map of the building, the representation of quantitative and qualitative information of the space of the place.

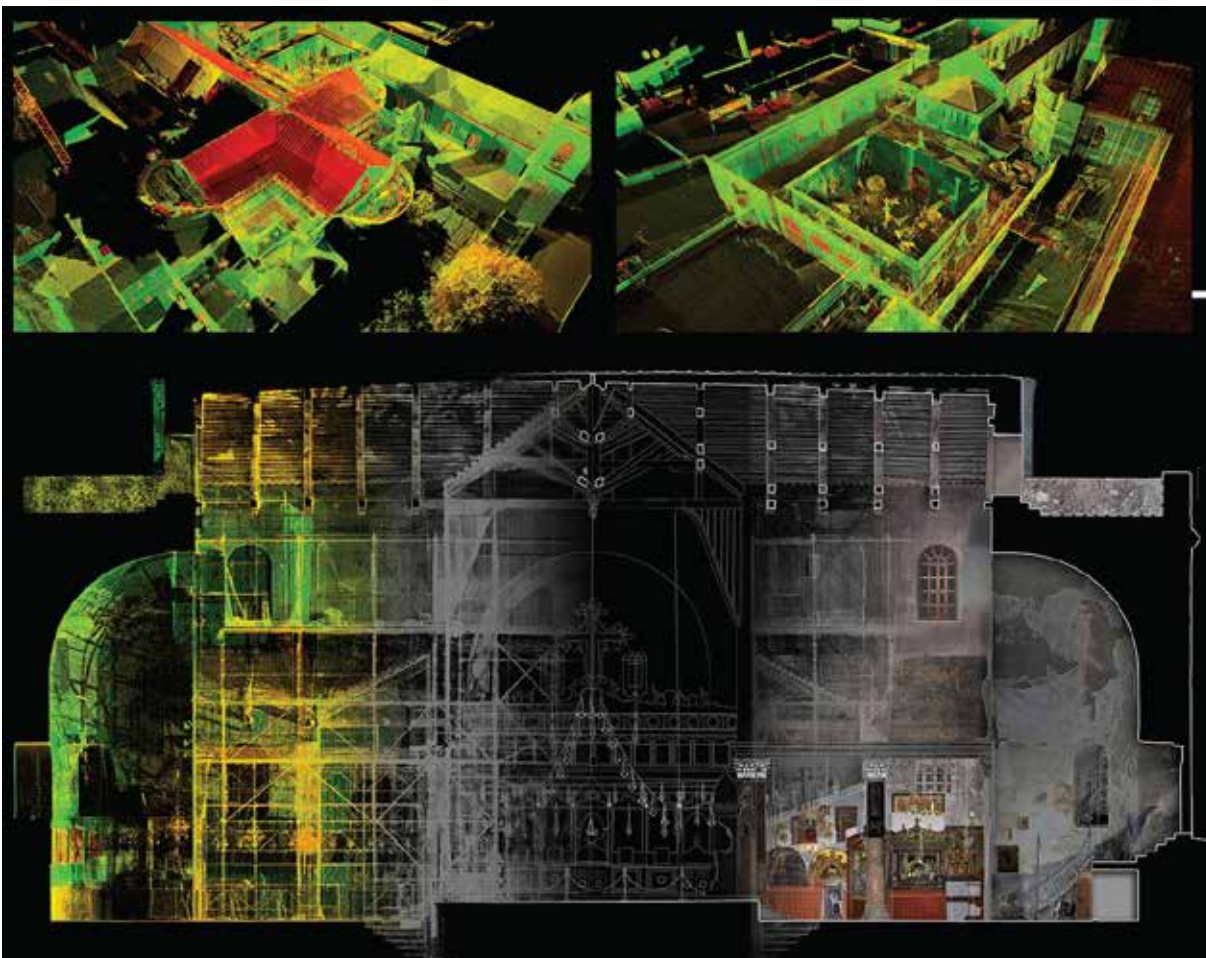


Fig.5 3D point cloud acquired by laser scanner survey and 2D restitution of a transversal section of the Nativity Church



Fig.6 3D textured model of the complex, obtained by SfM acquisition method

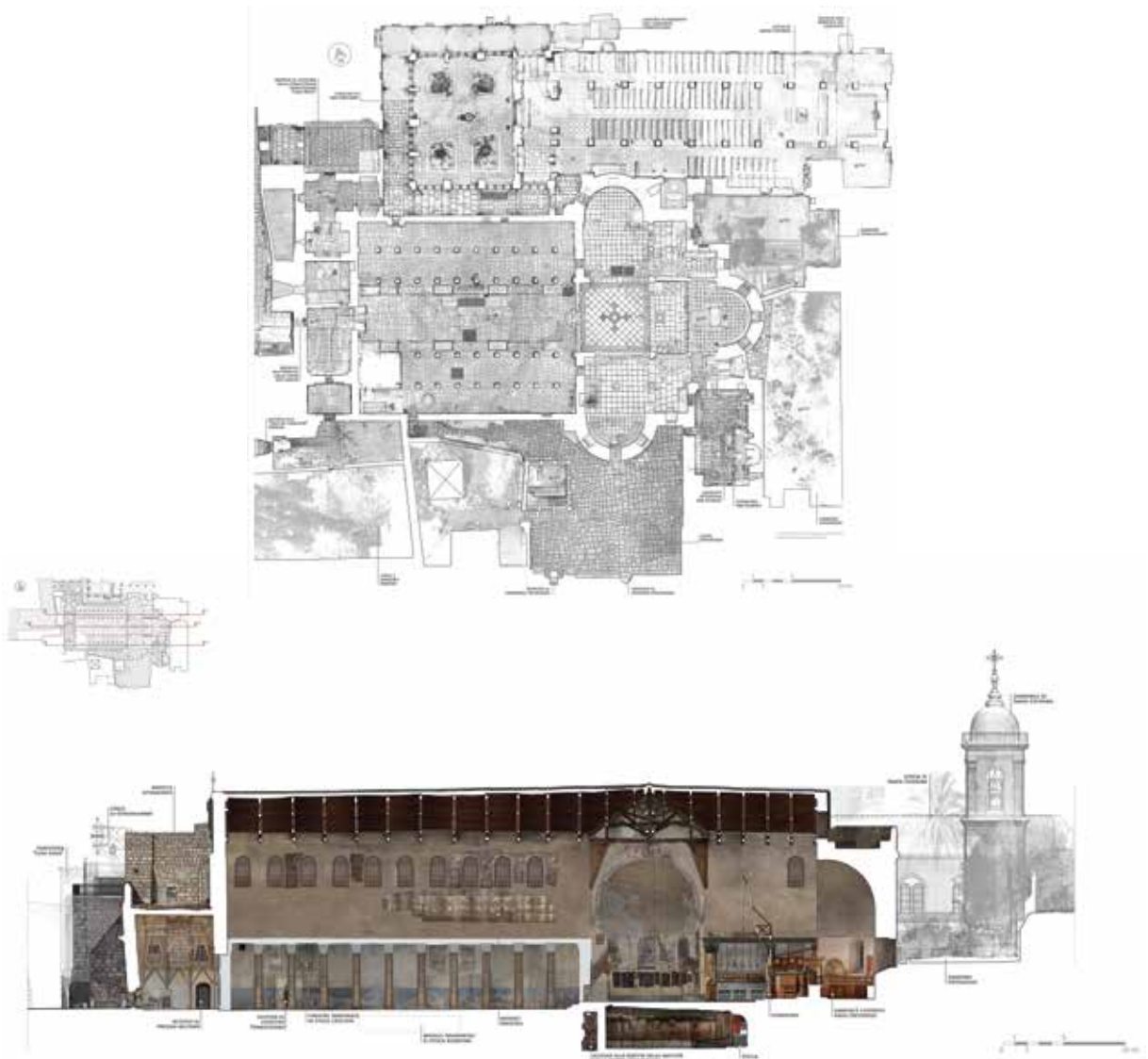


Fig.7 General plan and longitudinal section of the Nativity Church

CONCLUSIONS

The drawing expresses the relationships that determine the architectural structure through the use of a hierarchy of signs that, orientating the reading of the graphic text, highlight a structure to which it is necessary to refer when you intend to deal with a critical analysis related to the interpretation of the context. When the drawing is the result of a survey procedure on an artifact place, the data obtained by the investigations are collected and processed by the surveyors that sum to these aspects of the order the requirement for a metric dimensional control. This information, full filled with meaning, is subsequently used as the container of the data acquired through the various researches.

So a survey always requires the analysis of the different qualities of an object, the selection of those considered significant, and finally the synthesis of all of them made through a graphic model. We can subsequently have a survey for historical knowledge, a survey for the restoration, a survey for archaeological documentation, a survey for cataloging, a survey for the formal and dimensional knowledge and, finally, an experimental survey aimed to the didactic activity or rather aimed to the comprehension of instruments and methods. With this new approach the interaction between Heritage and Technology might be the proper manner to communicate the experience of visiting in a simple and focused way with respect to the type of users and visitors (SCIRES-IT, 2, 2015).

In order to satisfy the request addressed to heritage sites by the globalized tourism it is essential that professionals acknowledge the question of cross-cultural communication, and make a conscious effort to overcome these problems. Globalized heritage communication strategies should consider the archaeological areas, open air museums, as a “sensible system” where cultural differences may help conservators and institution in creating several different visitors interpretations.

New technologies have become a global developmental reality across the world irrespective of their economic contexts. However, the question of the accessible interface with these new tools and their cultural impacts has not been yet completely addressed.

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