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SEEING INTO THE PAST: INTEGRATING 3D DOCUMENTATION
AND NON-INVASIVE PROSPECTING METHODS
FOR THE ANALYSIS, UNDERSTANDING
AND RECONSTRUCTION OF THE ANCIENT POMPEII.
THE CASE OF THE HOUSE OF OBELLIO FIRMO (IX, 14)

1. THE FRAMEWORK OF THE *GRANDE PROGETTO POMPEI – PIANO DELLA CONOSCENZA*

In 2015 the Department of History and Cultures of the University of Bologna took part in the *Grande Progetto Pompei – Piano della Conoscenza*, with the task to accomplish a modern and complete documentation of the northern segment of the city (the so-called “Lotto 3”).

The *Grande Progetto Pompei*, financed by the European Union and Italy, is an ongoing very ambitious programme, which involves all the crucial aspects that a complex site like Pompeii has to offer, included the needs of knowledge, safety, conservation, capacity building, communication and fruition (<http://www.pompeisites.org/Sezione.jsp?idSezione=357>).

As part of this, the *Piano della Conoscenza* was a programme involving analytic documentation of the state of conservation of the ancient city, which promoted a detailed topographic survey and degradation mapping of all the surviving structures. To reach this goal the city was divided in 6 areas, which were assigned to 6 different project teams. The so-called “Lotto 3”, assigned to the University of Bologna, corresponds to the northern area of Pompeii (*Regiones* III, IV, V, IX), included between Via Vesuvio, Via Stabiana and Via dell’Abbondanza, for a total surface of 7.2 ha.

More in general, the new programme has become the fundamental instrument in systematically and continuously monitoring the site, finally, and for the first time ever, providing an accurate and comprehensive picture of the conservation state of every building in the ancient city. The huge computerized archive produced by the programme gave rise to an invaluable data bank, that is essential both for research and for scheduled maintenance as well as for planning the upcoming restorations out.

Before today, the monuments of Pompeii had a comprehensive mapping at a 1:500 scale. With the *Piano della Conoscenza*, a 1:50 scale survey was carried out, achieving a mapping that is 10 times more accurate than the previous one. This represents a very important and detailed record of all the survived archaeological evidence, articulated in walls, pavements, finishes and fixtures (such as balconies, *impluvia*, tubs, stairs, etc.). The new documentation is even more significant considering the mapping of all the elements

of disrepair, such as gaps and lesions, and of all the traces of plaster on the walls, as well as of the bricklaying techniques. All of these elements have been recorded and recreated also in shapefile format in order to connect and manage every information into a GIS platform.

The field work was organized in teams with archaeologists, topographers and photographers. The project also included inspections by teams made up of archaeologists, architects, restorers, engineers, and structural experts. Thanks to this collaboration, an interdisciplinary and complete documentation of the conservative state of the whole ancient city was accomplished, on which every building element is also quantifiable in terms of geographic referencing and metric extension.

The “Lotto 3” is characterized by the presence of buildings of particular relevance and high monumental impact, as the House of the Nozze d’Argento, the House of Marco Lucrezio Frontone, the House of Marco Lucrezio Stabia and the House of Obellio Firmo.

Besides an aerial photogrammetric survey by means of drones, the plano-altimetric and photogrammetric survey of the whole sector was accomplished using total stations, laser scanner and high-resolution cameras. This advanced topographic survey allowed the production of detailed plans, vertical sections and perspective drawings, with the characterization of the employed building techniques, as well as of a photogrammetric documentation that has constituted the basis for the analysis and mapping of materials and structural degradation in the whole “Lotto 3”.

2. NEW RESEARCH IN THE HOUSE OF OBELLIO FIRMO

After this experience, in 2016 a new project has been started in agreement with the former Soprintendenza Pompei, focused at the study, preservation and enhancement of the House of Obellio Firmo, always included in the northern sector of the ancient city.

This is one of the oldest *domus* in Pompeii, that was built during the pre-Roman Age for a local important family. It remains to be seen whether or not this family had been that of the *Obellii* ever since the origins of the house, a family who inhabited the structure prior to the eruption and played a leading role in the city’s politics.

The building is a big residential complex, which with the facade occupies the entire short side of the urban block, and is articulated on two *atria* and a peristyle. The first *atrium*, with Corinthian columns in tuff, was monumental and enriched by a fine marble decor aimed at underlined the aristocratic status of the owner. The second *atrium*, smaller and with Doric columns, was surrounded by residential and service rooms.

The new research contemplates an in-depth analysis of the house,



Fig. 1 – The House of Obellio Firmo, panoramic view and laser scanning survey 2016 of the tetrastyle atrium. Photo and data processing: M. Silani.

employing systematically laser scanning and photogrammetry methods in the direction to generate a geometrically and photometrically accurate 3D model of the whole building. To reach this goal we decided to repeat the laser scanning survey carried out during the *Piano della Conoscenza*, employing a laser scanner of new generation, which fosters the acquisition of highest quality 3D data and HDR imaging, warranting range and angular accuracy paired with low range noise and survey-grade dual-axis compensation. The new employed instrument led to a highly detailed 3D colour point clouds mapped in realistic clarity (Fig. 1).

The new laser scanner mapping will foster a detailed documentation in 1:50 scale, not only regarding the planimetry but also derivate products such as sections and prospects. Furthermore, it will also be possible to document recent restoring interventions carried out thanks to the *Grande Progetto*

Pompei and to compare the present structure's conditions to those recorded in 2015. Finally, the obtained millimetric detail will be essential to the surface modelling of the entire building.

In parallel, we proceeded with a further photogrammetric documentation by means of panoramic and full-frame Digital Single-Lens Reflex (DSLR) cameras, both for the colouring of point-clouds and for the extraction of high-res orthophotos to be applied to the 3D model in progress.

The new generated model is going to constitute the starting point for the further analysis of the walls' stratigraphy, with the aim to recognize and interpret the stratigraphic relationships between walls structures and stratigraphic units.

Thanks to these new experiences it has also been possible to document in high-resolution all the ornaments, paintings and finishes in terms both of rigorous geometry and of photo-realistic restitution.

In particular contexts such as the wall paintings of certain *cubicula*, it became necessary to document every detail with great care, both geometrically, by augmenting the single-scan resolution, and in the radiometric resolution. To that purpose, many images were acquired using different techniques and digital cameras. Taking advantage of these methods the following elements were acquired:

- a spherical image starting from the internal camera of the laser scanner itself, made by 274 photograms of 4 megapixel each to obtain a colossal spherical image with the 1 Gb scan;
- a spherical image, also with a camera inside the laser scanner, also made by 274 photograms, although acquired with the HDR technique, and a 3 step exposition for every single photogram, thus obtaining a spherical image of ca. 50 megapixel;
- a spherical image with the panoramic camera NcTech Istar 360, at a 9 step exposition to obtain a spherical image of 50 megapixel;
- and finally the acquisition of 15 photograms with a full frame camera Sony Alpha 7R II of 42,4 megapixel for the creation of a spherical image to apply by means of point cloud.

Experimenting different techniques of acquisition and comparing results let us define the best solution for the documentation of the main decorative features and their relative details.

In the same manner, it was decided to augment the detail level in the documentation of certain small objects inside the House of Obellio Firmo.

Keeping going down this road, the main elements of the furniture, such as the *lararium*, the *tabula vasaria*, the *trapezofori* and the wooden strongbox, have been measured having recourse to structured-light 3D scanner, able to reach an accuracy under the millimeter and an exact geometric reconstruction of the surface shape.

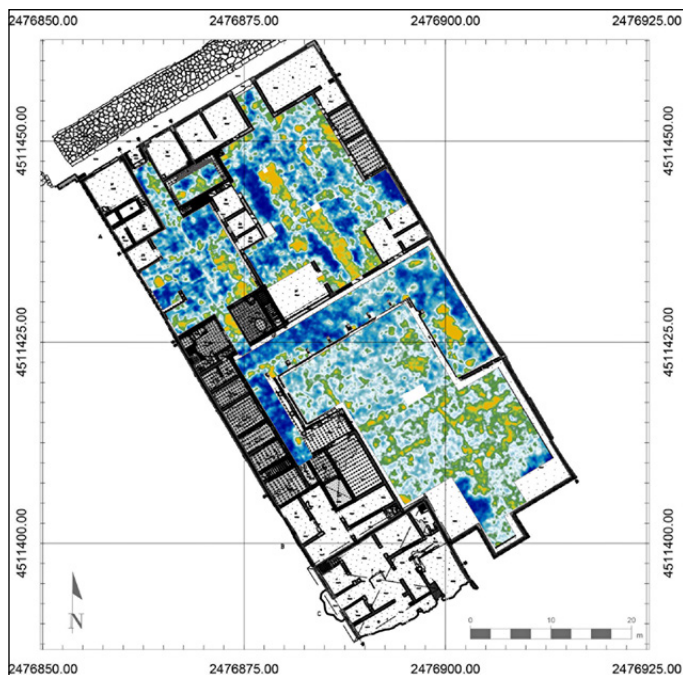


Fig. 2 – House of Obellio Firmo, GPR survey of the main open spaces. Slice maps' depth 0.50-0.70 m. Data processing: F. Boschi.

The full-scale deepened documentation of the house also includes a detailed geophysical mapping of all the accessible domestic spaces, systematically employing the ground penetrating radar technique. The survey, carrying out using a system equipped with a 600 MHz antenna, was characterized by an extremely high resolution data recording. This has fostered the production of a detailed 3D documentation of also the evidence that lies beneath the surface, represented by the numerous slice-maps which describe the subsoil under pavements and ground at different depths.

At the present state of works the high-resolution Ground Penetrating Radar (GPR) mapping covered all the largest open spaces of the building, included both the *atria*, the *peristilium*, the garden of the *peristilium*, as well as many others smaller service and domestic rooms (Fig. 2).

Besides the detection of all the buried infrastructures, such as pipelines and tanks, particularly impressive are the data collected in the garden. Indeed, here the geophysical survey clearly shows the presence of remains of foundation walls, which for characteristics of shape, layout and dimensions are referable, with every probability, to earlier divisions of the housing unit.

3. NEXT STEPS AND EXPECTED RESULTS

The preliminary results achieved by the non-invasive prospecting survey are being integrated with the analysis of the standing walls, in terms of structural stratigraphy, building techniques and materials. This combined work has been supporting in a worthwhile way the archaeological reconstruction and interpretation of the house's history, with regard to its first genesis as well as to its main development phases during the centuries.

To reach this goal, the management and sharing of the amount of the gathered information, related to both the out-of-ground elevated structures and the subsoil, will be organized within a comprehensive 3D model and within a Building Information Model (BIM). The 3D model, that is a work in progress, is a mesh model and represents the basis for the production of a parametric model, which will be managed in a BIM project.

The “total” approach we are adopting to study the House of Obellio Firmo, which we could define as four dimensional, aims to encourage the pursue of all the main goals of the projects, which includes:

- the reconstruction of the historical phases of the House, trying to go back in time before the moment fossilized by the eruption in 79 AD and with particular attention to the oldest Samnitic phases;
- the outline of a well-founded strategy of intervention for the next restoration activities of the whole building;
- the enhancement and public fruition of the House, only recently re-opened and integrated to tours¹.

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¹ This manuscript derives from the fruitful teamwork carried out on the field (and not just) by all the authors, who wrote together the first. The central part of the paper, entitled *New research in the House of Obellio Firmo*, is due to Michele Silani. The final paragraph is due to Federica Boschi. The included images were elaborated by Michele Silani and Federica Boschi on the basis of data owned by Soprintendenza Pompei.

ABSTRACT

In 2015 the Department of History and Cultures of the Bologna University took part in the *Grande Progetto Pompei – Piano della Conoscenza*, with the task of providing a modern and complete documentation of the so-called Lotto 3 in Pompeii. The new survey was carried out by means of integrated innovative diagnostic survey techniques in order to provide a total documentary research of the whole sector. In 2016 a new project was started in agreement with the competent Superintendency, and focused on the study and preservation of the House of Obellio Firmo, included in the Lotto 3 of the Roman city. The new research contemplates an in-depth analysis of the building, employing systematic laser scanning and photogrammetry methods to generate an accurate 3D model of the house. This model is going to constitute the starting point for the further analysis of the wall stratigraphies and for the mapping and monitoring of the structures' state of decay. The full-scale analytical documentation of the building also includes a detailed geophysical mapping of all the accessible domestic spaces, by using the ground penetrating radar technique. The preliminary results achieved by the non-invasive prospecting survey, integrated with the analysis of the surviving walls and building techniques, supply valid information for the archaeological interpretation of the house's history. In order to allow the management and sharing of the information collected, the data are going to be organised within a building information model (BIM) with a triple objective: the reconstruction of a fragment of the ancient urban landscape in Pompeii during the oldest phase, with particular attention directed to the Samnitic period; the outlining of a precise strategy of intervention for the restoration and preservation of the House of Obellio Firmo; the re-opening of the building to sightseeing tours and its restitution to public use.

