Survey, Documentation and Analysis of the Archeological Architecture: the House of the Knights of Rhodes in the Forum of Augustus

Bianchini C. and Tacchi G.L.

Abstract
The study and interpretation of the so-called Archeological Architecture is generally quite a difficult task: such elements or complexes nowadays show in fact very stratified and heavily restored configurations resulting from centuries of interventions.
Survey represents one of the major instruments for deeply investigating the intimate nature of such artifacts thanks to its ability to enlighten both the studied object and its context, their mutual relationships and the sequence of transformations.
Survey has to be intended though as an “open” process aiming at improving the general Level of Knowledge of the studied object; a process in which three main phases can be recognized: Data Acquisition, Data Selection and Interpretation, Communication. Phase one includes all information-gathering activities coming mainly from measurements and, under certain conditions, it leads to datasets “tending” to be objective. Conversely, during the Selection and Interpretation phase this database is “intelligently” reviewed for a critical selection and interpretation leading thus to “subjective” results. Finally, during the Communication phase results are codified in order to make them widely available for the scientific community.
The whole process always starts from getting acquainted with the artifact by direct inspection and by an historical investigation of archive sources (documents, drawings, pictures, etc.) able in outlining the timing and evolution of changes. All this information would in fact crucially guide the following operations of data capturing (surveying).
From this standpoint the House of the Knights of Rhodes in the Forum of Augustus is quite emblematic: no recent and systematic documentation is in fact available; present building is the result of many historical phases that have over time added or subtracted elements to the original roman building; the complex is actually a tangle of architectural and archaeological elements and for this reason it can be assumed as a “showcase”; finally the researches on the House, as relevant part of the Forum of Augustus, have received a new significant impulse by some recent excavations campaigns.
The research on the House of the Knights of Rhodes we are presenting has been then focusing on all these issues, aiming at demonstrating both the inner “coherence” of the Survey process and the potentials of the Integrated Survey procedures where many surveying techniques (3D scan, photomodeling, ortophotography, topography, GPS, direct survey) are used at the same time in order to optimize time, resources, models and results.
Models (2D, 3D) have been positively used to investigate this very fragmented portion of the Roman Forum (the building itself, the context of which it is part, the overall alignment of ancient structures, the consistency of buildings as well as the functions they used to host) not neglecting their role as means for communication of results and dissemination.

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Survey, Documentation and Analysis of the Archeological Architecture: the House of the Knights of Rhodes in the Forum of Augustus

Carlo BIANCHINI, Gaia Lisa TACCHI
Department of History, Drawing and Restoration of Architecture, Sapienza - University of Rome, Rome, Italy
Carlo.bianchini@uniroma1.it, gaialisa.tacchi@uniroma1.it

Abstract

The study and interpretation of the so-called Archeological Architecture is generally quite a difficult task: such elements or complexes nowadays show in fact very stratified and heavily restored configurations resulting from centuries of interventions. Survey represents one of the major instruments for deeply investigating the intimate nature of such artifacts thanks to its ability to enlighten both the studied object and its context, their mutual relationships and the sequence of transformations. Survey has to be intended though as an 'open' process aiming at improving the general Level of Knowledge of the studied object: a process in which three main phases can be recognized: Data Acquisition, Data Selection and Interpretation, Communication. Phase one includes all information-gathering activities coming mainly from measurements and, under certain conditions, it leads to datasets ‘tending’ to be objective. Conversely, during the Selection and Interpretation phase this database is ‘intelligently’ reviewed for a critical selection and interpretation leading thus to ‘subjective’ results. Finally, during the Communication phase results are codified in order to make them widely available for the scientific community.

The whole process always starts from getting acquainted with the artifact by direct inspection and by an historical investigation of archive sources (documents, drawings, pictures, etc.) able in outlining the timing and evolution of changes. All this information would in fact crucially guide the following operations of data capturing (surveying).

From this standpoint the House of the Knights of Rhodes in the Forum of Augustus is quite emblematic: no recent and systematic documentation is in fact available; present building is the result of many historical phases that have over time added or subtracted elements to the original roman building: the complex is actually a tangle of architectural and archeological elements and for this reason it can be assumed as a ‘showcase’: finally the researches on the House, as relevant part of the Forum of Augustus, have received a new significant impulse by some recent excavations campaigns.

The research on the House of the Knights of Rhodes we are presenting has been then focusing on all these issues, aiming at demonstrating both the inner ‘coherence’ of the Survey process and the potentials of the Integrated Survey procedures where many surveying techniques (3D scan, photomodeling, orthophotography, topography, GPS, direct survey) are used at the same time in order to optimize time, resources, models and results.

Models (2D, 3D) have been positively used to investigate this very fragmented portion of the Roman Forum (the building itself, the context of which it is part, the overall alignment of ancient structures, the consistency of buildings as well as the functions they used to host) not neglecting their role as means for communication of results and dissemination.

Keywords: Integrated Survey, Archaeological Architecture, House of the Knights of Rhodes, 3D Capturing

1. General Issues

Italy is undoubtedly characterized by the presence of a large number of architectures of the past: some of them testify the passage of time, showing a layering generated by the many structural changes from which they were concerned over the centuries. The study and interpretation of the stratified architecture, and more generally of the historical one, is a difficult to manage operation. The great importance assumed in Italy by the culture of conservation and restoration has provided a major boost to further research in the documentation and in the survey of these structures; the ultimate goal was often the return to the community, making them museums or containers of culture, preserving intact their architectural qualities.

The survey is one of the main tools for deep investigation of these artifacts thanks to its ability to understand the object of study and to put it in its context, as well as to decipher the relationships between the different components and the temporal sequence of the constructive transformations.

This particular contribution, regarding the experience of the Survey of the House of the Knights of Rhodes in the Forum of Augustus,1 fits into continuity with the work done by the School of Survey of Sapienza University of Rome, which has focused for decades on the analysis and the arrangement of various advanced methodologies to be used in the activity of survey documentation of the architecture, in particular the complex and layered one, as well as the so-called archaeological architecture.

The methodological study on the House may be an exemplary and emblematic contribution in the context of layered architecture: the current building is the product of a centuries-old layering, and there is not a recent complete documentation about it, neither of the survey kind nor

1The contribution derives from the research carried out as part of the Doctoral Thesis in Sciences of Survey Representation - Sapienza University of Rome - by Gaia Lisa Tacchi entitled ‘Documentazione e conoscenza di complessi architettonici stratificati: rilievo integrato e rappresentazione della Casa dei Cavallieri di Rodi al Foro di Augusto’. Supervisors professor C. Bianchini and professor M. Docci (http://padis.uniroma1.it/handle/10865/2069).
other. Furthermore, highly relevant architectural and archaeological elements coexist in it, as it is placed in the wider context of the Forum of Augustus, which, in the light of the recent excavations\(^2\) (Fig. 1), is the subject of a significant renewal of the studies.

The graphic and iconographic documentation on the House of Rhodes is on the contrary rather significant, given its interconnection with the structures of the Imperial Forum, and given the long period of time in which the building has developed its phases of construction, from the late Republican Age until today. The morphology and appearance of the building have changed over time, as well as its function and naming.\(^3\)

The overall survey of the building placed in its context may be a valuable tool for morphological reconstruction of the fragmented archaeological site. Parts no longer in contact with each other, even though coeval, may be connected again, establishing and verifying alignments that can lead to different interpretations of the planimetry, consistency and intended use of the old buildings.

2. Scientific Survey as implementable System of Knowledge

The investigation of the House of the Knights of Rhodes was conceived as an ‘open’ process, consisting of the creation of a knowledge system ever implementable, based on an integrated survey - carried out in a scientific manner - that uses verifiable existing data and can therefore become usable for the scientific community in the future.

The study had among its main objectives the demonstration of the internal consistency of the used methodological investigation process, built on the capabilities of the different methodologies of survey - 3D scanning, photomodeling, orthophotography, topography, GPS, direct survey - integrated with each other in order to optimize the processing time, the available resources, the proposed representative models and the results of the research.


\(^3\) The historical iconography consists of several modes of expression, depending on the historical period in which it is produced, and this happens in parallel, over the time, with the gradual transformation of the architectural structures: from the early sixteenth notes (Sangallo, 1516) that focus the attention on the consistency of the emerging structures in the area of the Roman Forum and restitute part of the oldest structure of the House, to the seventeenth and eighteenth centuries views that represent it in its relationship with the context - at the time a dense urban fabric - when it was part of the subsequently demesnised Convent of SS. Annunziata (Albo Giovannini, 1618; Michel d’Overbeke, 1769), up to the twentieth century metric processing aimed at the discovery and valorization of the complex following the ‘excavations of liberation’ of the Forum made during the Fascism, the demolitions that spared the House making it de facto the symbol of the memory of the site. See: BUZZETTI C., GISMONDI I. (1985); FIORINI G. (1995).
data useful in the control of wall structures adjacent to the House, also part of the same archaeological site, and of which we had an unverifiable graphic documentation. Also from the dimensional representation point of view, the point cloud could allow the realization of a three-dimensional model in a semi-automatic and sufficiently reliable and communicative way, at least for the parts with complex morphology.

The upper parts of the House were predominantly simple volumes, consisting of plans or however sufficiently regular surfaces; structures regulated by geometries identifiable from points that could be selected in the design phase of the survey; the interior could also be detected by points, while presenting decorative episodes (capitals and bas-relief) - and also a very large fresco - that deserved special attention in the process of detection. In this case the topographic surveying, that however would have been the basis and prerequisite of all survey activities - as an element of mediation between the different integrated detection techniques - could be enough to identify the main points of the architectural shapes, to detect with greater accuracy the edges (even in the presence of laser scans) and to form the basis for photo straightening - useful to the reading of the stratigraphy present on the masonry walls although flat - panoramic pictures - for the documentation of frescoed walls - and some test of photo modeling on capitals and small size relief structures.

Other considerations were carried out with regard to the vastness of the complex to be detected: having not as target a survey limited only to the building of the House of the Knights, but rather the investigation of the relationships and the changes that occurred within the complex system to get to reconstruct the building phases from which it was conceived over the time, it was necessary for the general survey not to arrive at a scale with a denominator too small. We then opted for the use of scale 1:100 in the two-dimensional representations, an unusual choice in architecture: this allowed us to have a pool of data not too large and therefore more manageable. From time to time, when necessary, starting from the main structure we reached a greater detail by increasing the data, the study and the representation of elements of particular interest.

The study aimed to understand the sequence of the structural transformations of the building and of its context from the creation of the first group - of which remains only a four sided travertine portico presumably of late Republican age - to its current configuration. In this sense, we would have data from the survey or from the direct ‘reading’ of the building and other types of information from literature and archival sources, as well as from historical iconography and most of all from the important survey drafted in 1930 by Italo Gismondi (Fig. 3). The next step would be to combine the data, that is construct two-dimensional geo-referenced models to put in relation with charts drawn up by the archaeologists that, in the past and even now, dedicated themselves to the archaeological site object of our interest. So another preliminary observation was made on the need to work on the field as a team in a multidisciplinary manner.

It was clear in this context that, after having synthetically derived the transformations occurred over time - on two-dimensional models - it was useful to make a three-dimensional representation of the sequence of construction phases along the line of time: a simplified model, neutral, constructed from the survey data, that would first check - even metrically - the reconstructive hypotheses carried out by Gismondi and other researchers, and that could also be a means for communication of the aforementioned modifications.

4. Survey Project and Data Acquisition

In order to optimize resources through the use of existing verifiable material, the survey project included the existing data of a survey campaign of the late Republican portico, now the Chapel of St. John.\(^5\) The data consisted of a 3D laser scanning and a support topography used for the recording of

\(^5\) The measurements of the Forum of Augustus taken by Italo Gismondi in 1930-31 for the *X Division of the Governorate of Rome* after the excavations of 1926-29, were published in 1935. They constitute an important contribution because the author has increased the knowledge of the building adding constructive data to the metric ones, assuming the dating for several layered and interconnected masonry apparatuses. See: Buzzetti and Gismondi 1983.

\(^5\) The working experience of the Chapel of St. John, led by prof. Carlo Blanchini, started at the ‘archeo - Architecture for Archaeology, Archaeology of Architecture’ Master, held at the Sapienza - University of Rome and coordinated by dr. Claudia Cecamore.
the point cloud (Fig. 4). Starting from the points measured in this initial topography, a closed polygonal, external and compensated, was built to be the essential basis reference system for all the other detection techniques integrated to it.\(^8\) The absolute coordinates spatial reference for the topographical reference points, useful to georeference the points of the polygonal and with it the survey as a whole, was determined using a GPS system.

The topographic survey, as planned, involved some points of the exterior of the building, selected at the beginning, the interior - consisting of simple geometries - , and provided the support for the realization of photo straightening of flat walls. The points of the station related to the external polygonal were used for the realization of a campaign of 3d laser scans,\(^7\) concentrated mainly on the outside of the building: these data have allowed to study, measure, and reconstruct the extremity complex surface of the architectural work providing the level of precision and accuracy required in the study (average < 4 mm.). Furthermore, as expected, the large amount of data from fast acquisition scans has allowed the metric control of almost the whole site.

\(^5\)The constraint in the archaeological site in order to close the external polygonal belong to different natures: the strong difference in height between the archaeological area and the entry level to the building on the 'Salita del Grillo', and the forced path to make a complete circuit around the complex are the main ones. As a result of this, the points of the station had to be numerous while the area of the polygonal had inhomogeneous lengths. The polygonal has shown an error of closure of 2 cm on 9 points of the station, and while it was a more than acceptable error for the chosen scale of restitution - 1:100 - precisely because of the inhomogeneity of its components, we preferred to offset it.

\(^7\)The type of laser scanner used is the Leica C10 model.

To facilitate and optimize the detection operations, the scanner was used in 'topographical mode', namely entering, one by one, the coordinates of the topographical landmarks inside the instrument, and directing it from time to time on the other cornerstones of known coordinates; this procedure has speeded processing operations of point clouds that are produced automatically recorded, that is to say joined and oriented between them. This method of scanning has allowed us to measure some new topographical landmarks that for logistical reasons had not been previously examined with the total station. The key points, known points, are a fixed reference system, to which you can couple every time you want to increase the data with survey campaigns to come, our own or of other scholars who wish to take up the work and carry it forward, in our view a fundamental assumption in research activities (Figs. 5 and 6).

The detection of the detail elements has been performed in different ways depending on the need to return them with a two-dimensional processing - in relation to the scale of return, which in this case is not a scale of detail, being the ratio 1:100 - or to obtain three-dimensional processing. Some essays of photo modeling were, however, carried out as a sort of experimentation and integration of the detection activity. These essays were performed using an Autodesk open source software - 123D Catch - on particularly interesting architectural details or on sculptural elements and decorations found in many parts of the building.

5. Data Selection and Interpretation: from the updated cartography to the model of the different phases of construction

With regard to the survey restitution, the above procedure has been realized organized in two phases: the creation of 2D models to be compared with the existing iconography and, therefore, the use of survey data to create a synthetic three dimensional model representing the results of this cross-referenced information analysis. This last phase
**Figure 5.** Geometric Survey. Restitution of the implemented survey methodology: topography, four-sided portico level plan.

**Figure 6.** Geometric Survey. Restitution of the implemented survey methodology: laser scans, four-sided portico level plan.
**Figure 7.** Modeling of the morphologically complex parts made from the point cloud to be assembled in the general model. The connecting structures between the building and the Forum of Trajan (Software Cyclone and Geomagic).

**Figure 8.** Textured model of an important element for the understanding of the historical stratification of the house. This is a portion of the vault with remains of decorated stucco against the wall on the Forum of Trajan. Processing of data from the point cloud (3D laser scans on the niche) and from the photo modeling of stucco (Software Cyclone, 123D Catch, 3DStudio Max with V-Ray).

has widely used numerical modelers that have allowed a more free definition of morphologically complex shapes, not based on geometric primitives, and that could easily include data from 3D scans (Fig. 7) or from photo modeling (this last mainly using Autodesk 123D Catch software)

The major construction phases have been represented, in their evolution, through a schematic model of the building and of the immediately adjacent environment. Almost all of the structural changes represented are based on reconstructive studies prepared by scholars, published and known, but generally enclosed in particular studies and not really about the House of Rhodes, but about the buildings adjacent to it and that in one way or another have concerned and changed it (Figs. 9-13). In the selection of the evolutionary phases of the building to represent, we followed a chronological order and turned the attention to those which have seriously changed the morphology of the building making it progressively as we see it today, to those that have changed its relationships with the outside, and to the moments that have built wall alignments and defined spot elevations, obviously being shape generators. The deducted phases were called in this way: late Republican

\[\text{FIGURE 11. A 1930 THREE-DIMENSIONAL RECONSTRUCTIVE DRAWING BY ITALO GISMONDI DEPICTING THE DOMITIAN WALL WITH A HYPOTHESIS OF THE MONUMENTAL STAIRCASE UNWINDING (BUZZETTI, GISMONDI, 1985; MENEGHINI, 2009).}\]

\[\text{FIGURE 12. TRAJAN PERIOD. ROBERTO MENEGHINI PRODUCED SOME HYPOTHETICAL RECONSTRUCTIONS OF THE STRUCTURES THAT AT THIS STAGE LEANED ON THE DOMITIAN PROSPECT. FROM A COMPARISON OF THE CURRENT SURVEY WITH THIS RECONSTRUCTION, THE MARK OF THE STRUCTURES THAT NO LONGER EXIST ON THE CURRENT PROSPECTUS HAS BEEN IDENTIFIED, CONFIRMING HIS HYPOTHESIS OF READING (MENEGHINI, 2009).}\]

For the reconstruction of morphologically complex structures, we used the meshed point cloud, for the simple volumes we proceeded with two-dimensional graphics modeling; for the reconstructed parts we deliberately used simplified forms for the hypothesized quality that characterizes them. Reference software used: processing point cloud Cyclone 7.3.3, Geomagic 11; photo modeling 123D Catch; modeling and rendering 3D Studio Max with V Ray.

and Augustan period; Domitian period; Trajan period; Renaissance period; post Renaissance and modern period; current period9 (Figs. 14 -15).

6. Conclusions

The main objective of this study was to lay the foundation for a system of knowledge concerning the House of the Knights of Rhodes based on an integrated survey, implementing all the available cognitive material on the building and opening up new prospects of research. The new study has in particular allowed, due to the potential expressed by the point clouds processing, to be aware of the inclination of a Domitian period wall, apparently quite flat, corresponding to the prospectus crowned by the Renaissance loggia, called 'Domitian Terrace'10 (Fig. 16), and to evaluate its angle. Since these changes are not easily visible to the naked eye, they are difficult to include in a selective investigation because they can’t be a subject of study. The interest in this kind of ‘discoveries’ is based on the amount of information that they can provide to the scholars who for many years have focused on the analysis of the layered walls of the building, and to those who, like us, investigates the methodological usefulness of new techniques for detection and the possibility of processing the collected data.

9 During the Renaissance, the building of the House of the Knights looked similar to the current days, then it was gradually the subject of an intensive use of the area, being included in a monetary leasing against the thick retaining wall of the Forum of Augustus. The progressive building development of the site has stopped with the demolition of the 'Alessandrino' neighborhood to free the Forum, an operation that saved the House of the Knights of Rhodes as a symbol of remembrance of the site destined to the Museum of the finds from the Roman Forum. For documentation on the historical phases beginning from the Renaissance, see: DANESI SQUARZINA, S. (1989); RICCI, C. (1925-26); RICCI, C. (1930); PIETRANGELI, C., PECCHIOLI, A. (1981); LEONI, R., MARGIOTTA, A. (2007).

10 Much has been written about the so-called 'Domitian Terrace', the thick wall that, since the initial stage of its construction was crowned with a terrace - where the fifteenth-century loggia now stands. Studies on this wall are mainly dedicated to the understanding of its structure and its function. See TORTORICI, E. (1993) La Terrazza Domiziana, l'Acqua Marcia ed il Taglio della Sella tra Campidoglio e Quirinale. Bollettino Comunale 95, p. 7-24; MENEGHINI, R., SANTANGELO VALENZANI, R. (2009).

References


