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DIGITAL ANALYSIS OF ROMAN BUILDING COMPLEXES: A CASE STUDY OF THE HOUSE OF TOFELANUS VALENS (V 1, 28) IN POMPEII

Abstract: Investigation of ancient architecture allows for understanding their original morphology, function, and history, and to elaborate interpretative hypotheses and reconstructions based on several factors, such as the constructive and static logic, the type of materials, or the cultural and historical background. The use of digital technologies is aimed at a geometric survey of these complex structures in order to obtain an accurate 3D representation that, beyond digitally documenting and preserving them, can be used for analysis and interpretation.

In this vein, this paper is a result of an experimental analysis of complex built environments with the support of digital technologies within the research project of Building Archaeology. Specifically, the analysis through 3D digital models is applied to the House of Tofelanus Valens (V 1, 28) in Pompeii, a part of Insula V 1, excavated for the first time in 1875 and more recently investigated and studied by the University of Lund.

Keywords: digital technologies, 3D digital analysis, building archaeology, Roman architecture, Pompeii

1. Introduction

Analysis of ancient architecture allows for understanding the original morphology, function, and history of buildings, and to elaborate interpretative hypotheses and reconstructions that are based on several factors, such as the constructive and static logic, the materials used, the cultural background, the historical sources, or the parallelisms with contemporaneous cases.[1] Application of digital technologies and tools, such as laser scanning, photogrammetry, or image-based modelling, allows to survey and document these complex structures geometrically and to obtain 3D models which represent them with a margin of error of a few millimetres. The 3D digital representation, beyond digitally documenting and preserving these cultural assets, can have several other uses, such as supporting investigation and enhancing analysis and interpretation. In this context, the work presented in this paper results from an experiment carried out within the research project of Building Archaeology[2] to test how digital technologies can assist analysis of complex built

[1] Moro, Vico, Vassallo 2007, p. 1.

[2] Building Archaeology is a discipline that was born in the late twentieth century as a sub-discipline of archaeology, and it developed focusing on the elevated structures. Indeed, Building Archaeology concentrates on the reconstruction of the history of the ancient buildings through direct observations and stratigraphic analysis, analysis of the materials, building techniques, changes through time, etc. The nowadays digital recording methods and the consequent possibility to apply virtual visualisation techniques allow enhancing the discipline both at the methodological and interpretative level (Giles 2014).

environments and check whether they can contribute to verification of interpretative hypotheses. The building complex discussed in the present case study and analysed with the use of 3D digital models is the House of Tofelanus Valens in Pompeii.

Fig. 1. Plan of Insula V 1 in Pompeii. The area occupied by the House of Tofelanus Valens marked in red (© The Swedish Pompeii project; graphically modified by the author)

2. Archaeological context, previous research, and interpretations

The House of Tofelanus Valens (V 1, 28) is a part of Insula V 1 at the archaeological site of Pompeii [Fig. 1]. The building complex was excavated for the first time in 1875. The house spans *ca.* 100 m² and is situated in the southern part of the insula. It consists of a small central courtyard (Room **b**), accessible through a corridor (Room **a**), where some traces of decoration belonging to the Fourth Style and a *lararium* niche are preserved. According to the literature, Room **b** was

probably partly open on the roof, both for collecting rainwater in a basin (or used for craft activities as hypothesised by some scholars) and for lighting.[3] The courtyard provides access to four rooms and a narrow corridor. Most probably, an upper floor used to cover the extension of the house, except for the courtyard. A staircase, possibly leading to the second floor, remains and is placed in front of the eastern wall, next to the basin [Fig. 2]. The House's owner has been identified as Marcus Tofelanus Valens, thanks to an inscription on a marble plate: M TOFELANO MF VALENTI QVOD AMICO DONAVI ~~HS~~ N I,[4] mounted in the northern wall of the courtyard [Fig. 3]. Moreover, the complex has been considered a part of a larger estate controlled by the owner of Casa del Torello (V 1, 7).

Based on the floor material from Room **d**, consisting of brick tiles, and the lower parts of the wall made of waterproof plaster (also detected in Room **e**), one hypothesis is that at least part of the house was used for artisanal production depending on the water coming from the basin in Room **b**.[5]

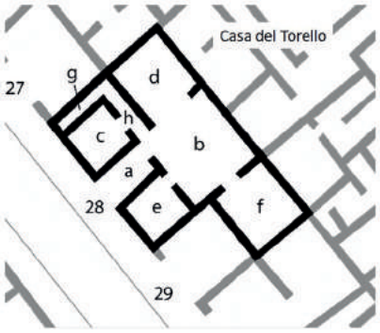

Fig. 2. Plan of the House of Tofelanus Valens

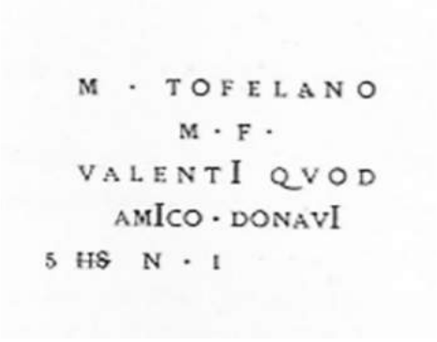

Fig. 3. Inscription of Tofelanus Valens (*CIL* X 866)

A narrow corridor to the north of the courtyard leads to Room **c**, whose function is unknown, and to a narrow room (Corridor **g**) situated in the north-western corner of the house: The latter is believed to have been used as a *latrina* or a staircase leading to the upper floor, but this has not been proven.[6] Also, the function of Room **f** remains unclear, and it was suggested that it may have been a master's bedroom or an artisanal production area. The house shows a number of building techniques and materials, indicating several re-building phases and repairs that are difficult to date.[7]

[3] Overbeck, Mau 1884, p. 271.

[4] Based on the transcription reported in *CIL* X 866 (p. 967), the Swedish Pompeii Project provides the following translation: "To Marcus Tofelanus Valens, son of Marcus, because I gave to my friend one sestertius coin". A slightly different interpretation is the one provided in the Epigraphic Database Clauss/Slaby (https://db.edcs.eu/epigr/epi_ergebnis.php), no. EDCS-11400953, where the text of the inscription is edited as follows: M(arco) Tofelano / M(arci) f(ilio) / Valenti(no) quod / amico donavi(t) / HS n(ummum) I. In this case, the provided translation is: "To Marcus Tofelanus Valentinus, son of Marcus, because he gave to his friend one sestertius coin".

[5] The archaeologists who first excavated the area of the House identified these rooms as the slaves' bedrooms (Overbeck, Mau 1884).

[6] Overbeck, Mau 1884, p. 271.

[7] Different materials are visible, used both for the façade and the internal part of the house: It starts with *opus incertum* of lava mixed with limestone in a yellowish mortar, the material used in the original building phase. The *opus* is often mixed with a variety of materials: The southern corner and the door frames are made of *opus testaceum*. The upper parts of the walls are in *opus reticulatum* of small square blocks. Instead, the zone with the upper floor windows is made of *opus vittatum mixtum* of bricks and small blocks of tuff stone.

According to the past studies and interpretations, this dwelling could have originally been a part of Casa del Torello (V 1, 7), forming a small atrium house extending towards the north-west of the insula.[8] The extension of the house was possibly larger in the previous phase: It may have been affected by the expansion of Casa del Torello during the first century AD. Other changes took place later, probably connected to the nearby buildings which affected the House of Tofelanus: The closure of an opening in the eastern wall of Room **b** and another closure in Room **f**, in place of a door and a window in the western wall connecting the room with *taberna* V 1, 29, was blocked. There are two plausible interpretations made by archaeologists: The House may have been resized, which would imply that the *taberna* was an earlier part of the house; alternatively, the House may have been enlarged and Room **f** served as a *retrobotega* of V 1, 29, thus forming a two-room dwelling, similar to spaces found in the southern part of the insula (e.g., V 1, 30 and V 1, 31).[9] In regard to further analysis, apart from seeing it as a simple small residential house (with no traces of artisanal production)[10] based on a lost painting reproducing a garden above the basin in Room **b**, the House was also interpreted as a workshop of a gold-smith.[11] In reality, the latter interpretation is not corroborated by an adequate number of jewels which would witness the proposed function and it might derive from an incorrect reading of the original excavation reports.

3. Analysing complex built environments with the use of digital technologies

In the previous studies, several different interpretations have been elaborated for the House. Moreover, it has been first excavated already in the nineteenth century, with methods very different from those used today, and subjected to different reconstructions, many of which cannot be easily linked to a particular chronological period [Fig. 4].[12]

Therefore, it is justified to ask whether the 3D digital analysis makes it possible to support and enhance the study of these archaeological remains and enable revisiting the past research.

Insula V, where the House of Tofelanus is located, has been quite recently investigated (and excavated in parts) by the University of Lund,[13] which involved its complete 3D survey. In two campaigns, the whole insula was digitally documented with a laser scanner and using the technique of photogrammetry. The 3D models obtained during the digital data acquisition and subsequent post-processing and reconstruction enable visiting the spaces virtually and investigating the relationship between their original states and the current archaeological context. Moreover, the digital 3D models of the remains (also published online) help visualise and analyse the building, simultaneously providing access to measurements and allowing for inspection of its characteristics.[14]

Thanks to the availability of its 3D replica, the small dwelling could be more easily analysed in regard to the relations between rooms, spaces, walls (their temporal sequences), as well as repairs and re-buildings that occurred over time.

[8] Staub 2013, p. 11.

[9] The doorway connecting Room **f** and the Courtyard **b** contains doorposts made of small tuff stone blocks. Such elements could suggest a later time of creation of the door, with the original belonging to the *taberna*.

[10] Overbeck, Mau 1884, pp. 271–272.

[11] Eschebach 1993, p. 128. Some years earlier, Eschebach published a plan of Pompeii providing a functional category (land-use analysis) of each excavated building. His work is, however, often misleading (Eschebach 1970).

[12] The various changes could belong to the last reconstructions after the earthquake of AD 62.

[13] The Swedish Pompeii Project is the name of an endeavour led by the University of Lund and aiming at documentation, analysis, study, and interpretation of Insula V 1 (http://www.pompejiprojektet.se/index.php). The 3D documentation of the insula was a result of collaboration between the Humanities Laboratory (HUMLab), the Institute of Archaeology and Ancient History, and the Digital Arkeologi Laboratoriet (DARKLab) at the University of Lund and the Istituto di Scienza e Tecnologie dell'Informazione "A. Faedo" (ISTI) at (CNR) Pisa.

[14] Dell'Unto *et alii* 2013a, pp. 199–207.

Hence, in the present study the elements of the building were analysed jointly with various digital tools, such as 2D and 3D visualisations or rendering functions, while the results derived from the 3D analysis were compared to those obtained from traditional investigation.

Fig. 4. Elements and architectonical details of the façade of the House of Tofelanus Valens (© The Swedish Pompeii Project)

4. The importance of graphic and digital documentation

In the past, as Eriksdotter underlines,[15] the study of architecture was treated as a kind of art history, and it was more focused on the pure description of monuments, aiming to date the building based on the style and manufacturing techniques.[16] The visual examination of a building may give preliminary answers and insights. However, only a careful and thorough documentation enable its thorough interpretation. Indeed, only detailed knowledge of the cultural heritage warrants successful processes of interpretation and communication. Primary, it is necessary to gather data, such as texts and archival material about the investigated structure. For instance, the study of ancient authors, *itineraria*, and ancient iconography is crucial for obtaining necessary information. In the case of a lack of information from such sources, comparison with historical and typological analogies is also fundamental.

Nevertheless, sometimes literary and archival sources are so limited that preserved buildings remain the only means to understand and interpret the archaeological record. In this case, the survey of architectural traces has an essential role. Indeed, in archaeology graphic documentation is necessary for the study and analysis of buildings. By collecting precise high-quality geometric data, it is possible to understand and interpret the history of a given building and draw conclusions about possible reconstructions based on logical interpretations and material-structural rules. The

[15] Eriksdotter 1997, p. 742.
[16] Samson 1990, p. 4. Nevertheless, this kind of analysis might be only partially correct, since the architectural elements can be reused over a long period of time.

study of the sources, the analysis of geometry and materials, the typology and its features all become fundamental to understanding and interpreting a building.[17]

In the case of House of Tofelanus, apart from some older general studies, there are no previous detailed plans, sections, or drawings that could be useful for a preliminary analysis of its spatial layout. The presence of such sources would be useful for comparing the data gathered in the past to that acquired with digital technologies.[18] The only source material for the House comes from the general description of the past excavations and the accounts of ancient authors regarding house typologies in the Roman times (Vitruvius, *De Architectura*), which can elucidate how particular spaces were used.[19] The Roman architecture in particular was characterised by recurrence of elements and fixed rules which today facilitate its interpretation and betray functions of particular structures.

Information about the current geometric state of the House of Tofelanus is now available thanks to the digital data acquisition performed after the last Swedish excavation campaign. The obtained 3D model is of great importance, because it provides a precise and measurable replica with an error of up to a few centimetres.[20] This enables analysing the geometry and architectural details of the structure.[21]

5. Human spatial behaviour, social space, and built environment

Before moving to the 2D and 3D analysis and interpretation of the digital data, it is essential to evaluate also the social aspect of architecture. Apart from studying technical side of buildings, it is important to investigate the social behaviour related to them: How people of the past perceived the space and environment, how they modified them, and how the architecture, in turn, affected the way they lived. The concept and perception of space involves interaction between and among people as well as between people and the space itself. For instance, any space is defined by boundaries. Boundaries create rooms inside a building or areas between other buildings and between these and the landscape. Therefore, space is a material and conceptual human construction affected by knowledge, ideas, and contingencies. For the study of ancient architecture, archaeologists have looked at buildings and rooms according to historical frameworks: aesthetic interpretations, typological studies, or physical factors. Meanwhile, other factors such as social causes and cultural influences should also be considered. As theorised by Hillier and Hanson, buildings are not just objects but a transformation of space through objects; the ordering of the space in buildings is about ordering relations between people.[22] Therefore, within such a theory, applied by Andersson to Pompeii, society plays a significant role, and the variations or similarities between buildings with the same function should reflect variations or similarities in the social milieu in which these buildings are situated in.[23]

[17] Vassallo, Moro, Vico 2006.
[18] Dell'Unto *et alii* 2013b, pp. 621–628.
[19] The only historical surviving treatise of the Roman age is *De architectura libri decem* by Vitruvius.
[20] In this specific case, the maximal error during the 3D data post-processing has been calculated to 0.002 cm.
[21] However, do we document what we see or do we interpret it? Theoretically, digital surveying helps overcome the major problem of subjectivity present during analogue documentation. It does so by creating a more objective and transparent product that is always reviewable. Nevertheless, it has its own limitations due to various factors, such as precision and accuracy of instruments or expertise of their operators (Guidi, Russo, Beraldin 2010, pp. 126–139).
[22] Hillier, Hanson 1984, pp. 26–29.
[23] Andersson 1997.

Therefore, following the theories about the social space applied by Andersson to Pompeii, it is interesting to investigate whether the spatial organisation reflects the social organisation, and vice versa, and to relate these notions to some research questions concerning the House of Tofelanus:

— How did the inhabitants of the House allocate and use its different spaces?

— Did the House change through time? How did spatial intentions and connections gradually transform? What were the original functions of the rooms? Did their intended use match what actually happened in practice?

— What were the modalities of moving within the House and the related areas (e.g., nearby Casa del Torello, the *tabernae*, and the adjacent house)?

— How were its different parts accessed? What were the relations between them?

These kinds of questions expand our understanding of spatial arrangement in the past and possibly reveal the character and use of the House of Tofelanus.

An important factor here is that the digital turn allows us today to move the concept of space into the cyberspace and evaluate hypotheses about ancient spatial and societal configurations through digital tools within virtual environments. In this frame, the 3D digital analysis facilitates responding to these questions and enables studying the building from a different perspective.

In Pompeii, the structure of houses, the paths, and the accesses are connected to movements and spaces and how the latter were perceived. The "economic, cultural, political, religious, and infrastructural behaviours produced different types and rhythms of movement and interaction in the Roman city, and those patterns of movement both responded to and generated particular configurations of urban and societal development".[24] Therefore, all the elements of the Roman town can be considered and understood as elements of inclusion and exclusion, distance and vicinity, relations between the whole and the parts, spaces and places.

The Space Syntax analysis, theorised by Hillier and Hanson, expresses these relations and tries to quantify the spatial interrelations between the built environment and human behaviours.[25] Furthermore, social relationships interfere with access (Access Analysis): For example, the political or socio-cultural element interferes with the movement and access in a house or a different part of a town (as well as the non-access to specific spaces for certain types of users).[26] For these reasons, as underlined by Van Nes,[27] Pompeii becomes a perfect case study for the analysis of interaction between public and private life through the use of the spatial theory, and particularly of the connection that accesses, doors, and windows have with streets and their exploitation by urban crowds. It is of fundamental importance to understand the relationship between a building and its neighbourhood and the "development of the town as a functioning, dynamic whole".[28] In this context, similar works were conducted in other insulae of Pompeii. In some cases, the developments or the different orientations of some houses were identified and connected to shifting

[24] Newsome 2011, p. 2.

[25] Space Syntax is a theory of architecture, statistical and computer-based, that originated in the 1980s from the work of Hillier and Hanson (Hillier, Hanson 1984). It was then applied further, in developing theoretical suppositions aimed at the analysis and interpretation of the urban space. Nevertheless, inconsistencies within the theory have been pointed out by some scholars, i.e., the impossibility for this analysis to consider the height of buildings and the sizes of streets (Ratti 2004), which was promptly addressed by the authors (Hillier, Penn 2004). Similarly, its limitations have already been exposed in archaeology in two ways: The spatial interpretations produced by its application do not always correspond with actual patterns, since they are only statistically probable, and can be proof-tested exclusively with archaeological evidence (Newsome 2009, p. 124).

[26] See Stöger 2011 for related bibliography and application in her research in Ostia.

[27] Van Nes 2011, p. 100.

[28] Newsome 2009, p. 123.

importance of a specific street.[29] These studies demonstrated the necessity of reading domestic development together with the patterns of urban spatial growth and change.[30]

6. Digital analysis of the structures

The House of Tofelanus Valens can be accessed from Via Vesuvio and, together with a set of large *tabernae*, it occupies the corner of Insula V, an area that was extensively rebuilt in the final decades of Pompeii. It constitutes an enclave, extending from Via di Vesuvio to the *fauces* of a small atrium house (*domus* V 1, 3) in Via di Nola. Its appearance raised many questions regarding the original land use in this urban block, because two other houses could be connected to that of Tofelanus during its older configuration.[31] In order to better analyse and interpret the relations between the spaces of the House of Tofelanus and the adjacent buildings, digital analysis and interpretations of the structures and rooms have been performed. This paper only reports on the rooms, spaces, and elements where the 2D and 3D analysis has so far allowed for better visualisation and interpretation.

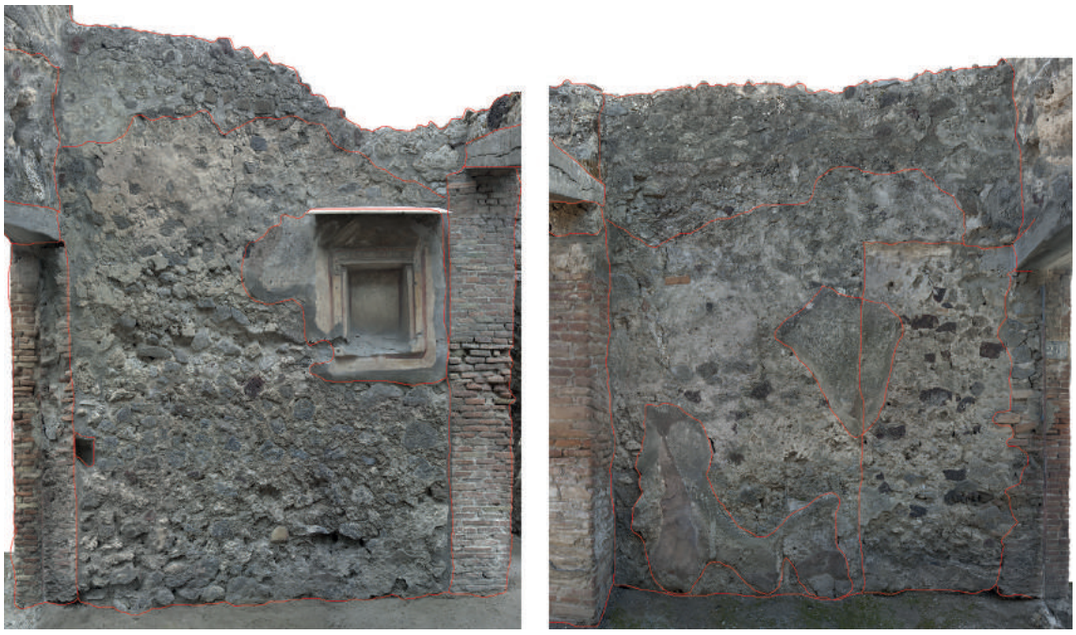

Fig. 5. 2D analysis of the northern and southern walls of Room **a**
(© The Swedish Pompeii Project; graphically modified by the author)

Room a

The *fauces* (the corridor) is the entrance to this small dwelling. The northern wall bears decoration belonging to the Fourth Style and a *lararium* niche.[32] Integration of the 2D analysis elaborated in Photoshop on orthorectified images [Fig. 5] and enhanced visualisation of the 3D model through

[29] For thorough case study references on the Space Syntax theories as used in archaeology, see Stöger 2011.
[30] Newsome 2009, p. 123.
[31] Leander Touati 2010.
[32] The niche is decorated in coloured plaster: yellow pilasters with red, white, and blue Corinthian capitals on the sides. Meanwhile, the top bears polychrome frames with palm motifs. Within the niche, plants are represented

MeshLab[33] shaders [Fig. 6] revealed that the walls consist of a mixture of different building materials and distinct repair and construction phases, probably connected to the earthquake of AD 62, as well as a modern reconstruction of the entrance. Particularly, the MeshLab lattice.gdp shader used to enhance the details of the 3D model confirmed the presence of an opening on the southern wall, blocked off later, which used to connect the entrance with Room **e**.

Moreover, the visualisation of the 3D model in MeshLab shows that the beam holes visible in the western wall of Room **a** are strictly aligned with the beam holes present in the lateral rooms, thus demonstrating the presence of an upper floor covering the whole area [Fig. 7]. The traces of beam holes are visible particularly clearly in Room **c** and Room **g**, but they seem to be abruptly interrupted, making one hypothesise that this part might have collapsed and was reconstructed later. According to what Dell'Unto *et alii* call reconstruction by "deduction", together with the "objectivity" (or data analysis), the presence of the array of holes in the wall corroborate the presumed existence of the second floor supported by beams.[34]

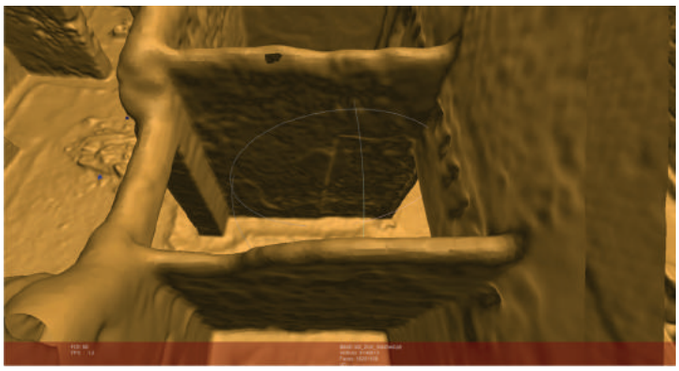

Fig. 6. Southern wall of Room **a** with the lattice.gdp shader visualisation that reveals the presence of an opening which was later blocked off

Fig. 7. Parallel beam holes witnessing the presence of an upper floor covering the whole front area of the House

on a panel of white background outlined in red; below, semicircle patterns are painted in yellow with thin frieze. On the base of the niche, cavities are still visible, which used to hold statuettes and are dated to the last phase of the House (Giacobello 2008, p. 231).

[33] MeshLab is an open-source software for 3D data post-processing and visualisation (http://meshlab.sourceforge.net/) developed by the Visual Computing Lab, ISTI-CNR.

[34] Beyond "deduction" and "objectivity", the authors speak about reconstruction by "testimony", "comparisons", "analogy or styles", and "hypothesis" (Dell'Unto *et alii* 2013b, p. 624).

Room f (external western wall, corresponding to the eastern wall of *taberna* V 1, 29)

In its final phase, Room **f** was a part of the House of Tofelanus Valens but shows an older connection with the *taberna* V 1, 29. Integration of 2D documentation with the construction technique analysis [Fig. 8] and the enhanced visualisation of the 3D model through the MeshLab Radiance scaling (Grey descriptor) [Fig. 9] revealed elements that prove this connection. There are, in fact, a couple of features — a door and a window — that have been blocked in the past, closing the access to the House of Tofelanus.

These features seem to confirm the hypothesis that the owner of the *taberna* was Tofelanus Valens and that the shop was leased to a different person at another point in time.[35] Tofelanus Valens would probably run the shop in the past, which would also explain the House's characteristics. In fact, according to the description of this building type in the ancient sources, the House would belong to a representative of the more modest social class: less wealthy freedmen, small traders, or craftsmen.[36] As for Vitruvius,[37] this social class of Pompeii, especially after the earthquake, occupied elective administrative positions and their homes were small (about 120–350 m^2) without a proper atrium but with rooms grouped around a covered courtyard (called *atrium testudinatum*), around a corridor (the so-called basilica house), around a *xystus* (an internal garden with one, two, or three arcades, i.e. a very small *peristilium*), or around a *viridarium* (a small garden closed by walls). Sometimes, there are cases presenting an intermediate form which also had prestigious areas, such as *triclinia* or an *oecus*. Most would have a small kitchen with an adjoining *latrina*. The House of Tofelanus seems to fit the Vitruvian description and resembles similar cases attributed to craftsmen and merchants.

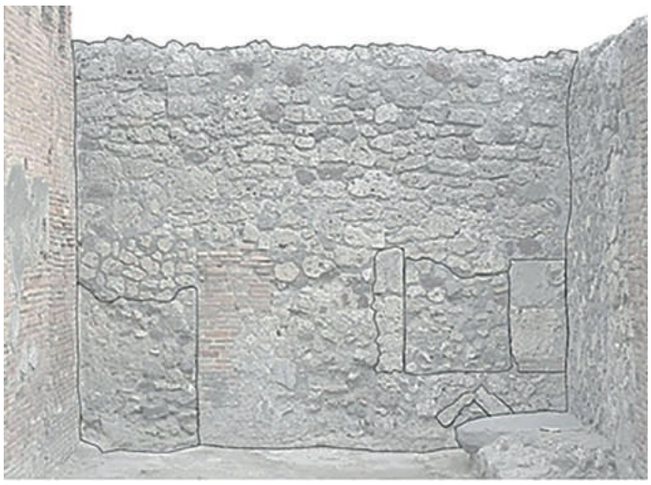

Fig. 8. 2D documentation enhanced by the building technique analysis of the external western wall of Room **f** and corresponding to the eastern wall of the *taberna* V 1, 29 (© The Swedish Pompeii Project)

[35] The person could have been called Auxilio, as suggested by a piece of graffiti that was originally visible on the façade.

[36] La Rocca, DeVos 1994, p. 42.

[37] "... igitur is, qui communi sunt fortuna, non necessaria magnifica vestibula nec tablina neque atria, quod aliis officia praestant ambiundo neque ab aliis ambiuntur..." (Vitr. *De arch.* 6.5.1).

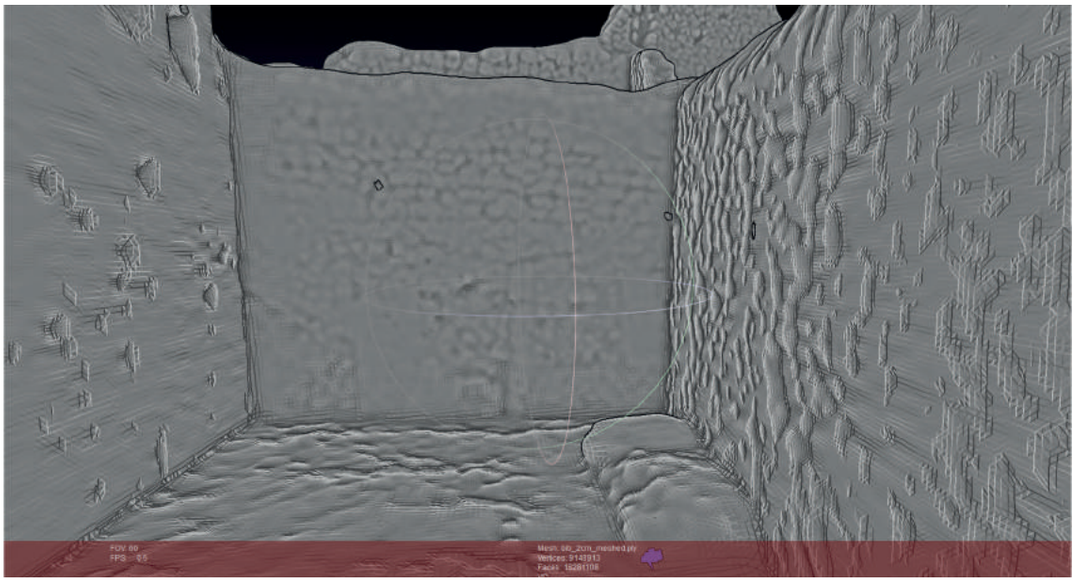

Fig. 9. MeshLab Radiance scaling (Grey descriptor) applied on the external western wall of Room **f**

Room b (eastern wall)

Room **b** is the central space of the House of Tofelanus Valens. The room is not a traditional atrium with a centrally-placed *impluvium* but has a water basin in its north-eastern corner, probably meant to gather rainwater.

Thanks to the 3D model and application of the MeshLab shaders (both the lattice.gdp and the Radiance scale-grey descriptor in this case), it was possible to highlight two details of the eastern wall of Room **b** [Figs. 10 and 11].

First of all, the stairs seem to have adjoined the water basin: This is indicated by the different sizes of the two elements, whereas the shaders revealed a detail of the first step of the staircase that extends to cover the basin. This element could not be seen in a simple, even high-resolution, 2D image and the only alternative way to identify it would be to examine the structure *in situ*. The technology confirmed findings of past studies and demonstrated the possibility that this room could have originally been open to gather rainwater and, of course, provide lighting to the surrounding areas. The staircase (with the first four steps in stone and the rest in wood) should have led to a second floor, most probably used as a dormitory or as a storage space. The second element, visible when the materials and masonry were enhanced with the 3D shaders, is the presence of an opening in Room **b**. The remains of a — possible — door, blocked off afterwards, is visible in the 2D image and through direct examination. However, the 3D analysis of the element indicates that the upper part of the door has an arched shape which could suggest that the opening was used as a passageway, probably closed with movable elements (curtains?). Alternatively, instead of acting as a door, the feature could have been a niche. Thus, there would be no access to the adjacent House, meaning that the House of Tofelanus was separated from it and, most likely, connected to the current *taberna* V 1, 29 instead. In support of the second hypothesis, the lack of traces[38] referring to an opening on the opposite side of the wall (interpreted as the kitchen of Casa

[38] Leander Touati 2010, p. 140.

del Torello) and the digital visual enhancement of its base at higher position in respect to the floor may corroborate the connection with the *taberna* rather than the nearby dwelling.

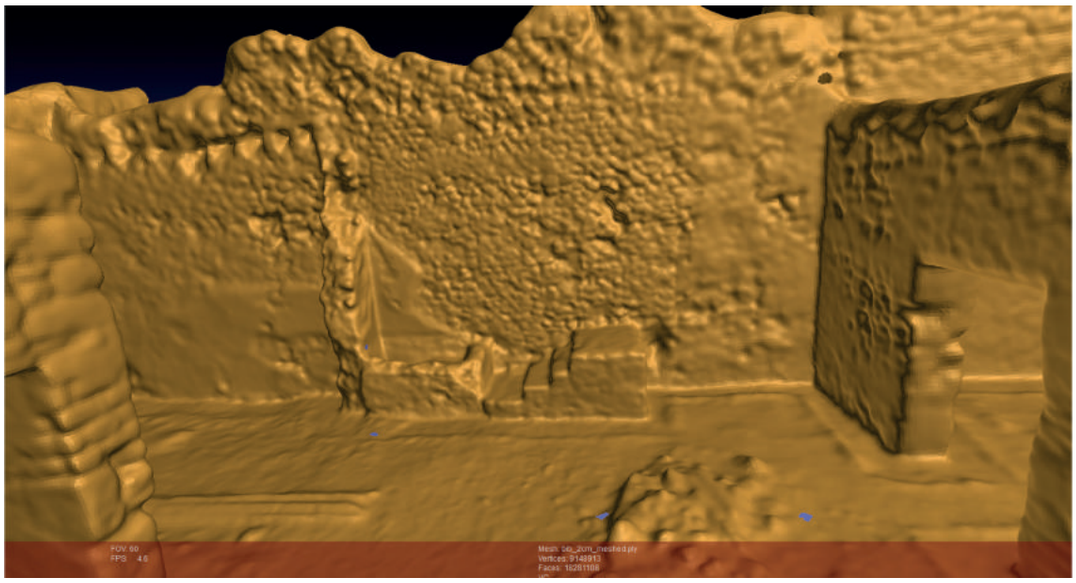

Fig. 10. Eastern wall of Room **b** with the lattice.gdp shader visualisation that reveals the distinct features of the basin and the staircase

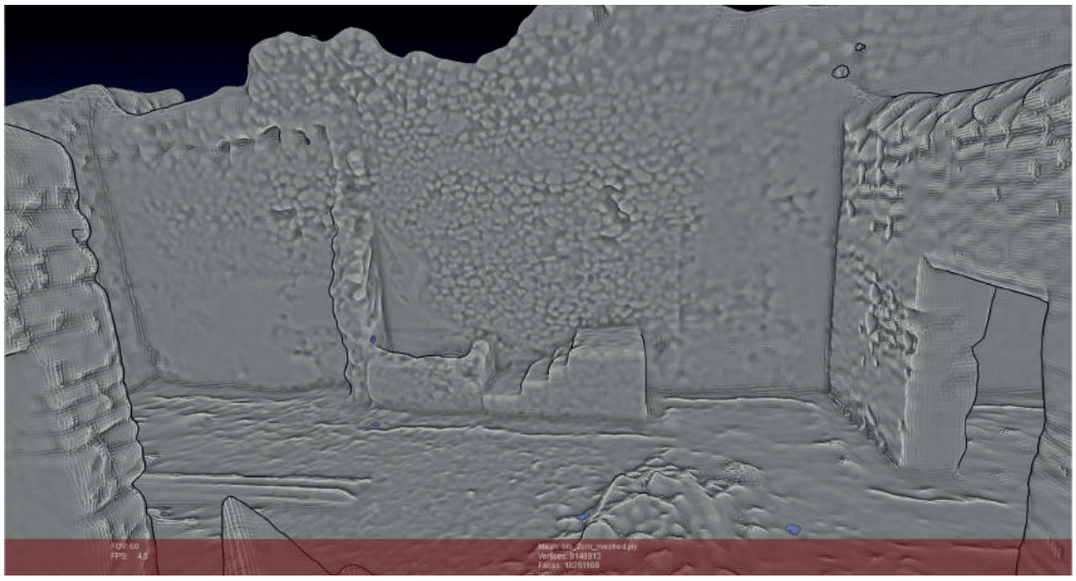

Fig. 11. MeshLab Radiance scaling (Grey descriptor) applied on the eastern wall of Room **b** reveals the shape of the blocked opening

7. Conclusions

After analysing the 3D model of the building through specific filters that enhanced the visibility of its architectural details, the plan of the House has been digitised [Fig. 12]. The structural elements have been vectorised for better clarity and to facilitate understanding the changes that occurred, such as the aforementioned openings and closures or the presence of the basin and the staircase.[39]

From the Space Syntax analysis carried out by Van Nes comes that "in Pompeii, the two main cross streets, Via Stabiana and Via di Nola, have the highest integration values, followed by the Via dell'Abbondanza. These high values result from their position and size within the orthogonal street grid". The shops are in fact exposed to the flow of people: They tended to be located in positions where numerous possible costumers would pass by. Following the spatial analysis elaborated by Van Nes in Pompeii and the identification of the neighbourhood of the House of Tofelanus as *tabernae* and *cauponae*[40] (as per archaeological evidence), it is possible to postulate that the small complex was a house of an artisan or merchant. The front rooms were likely used as production areas, and the products were sold in the adjacent V 1, 29 (identified as *taberna*, since it has direct access to the street, differently from the rooms **c** and **e** which are instead separated from the street). The front area was covered, as shown by the remains of beam holes supporting the second floor.

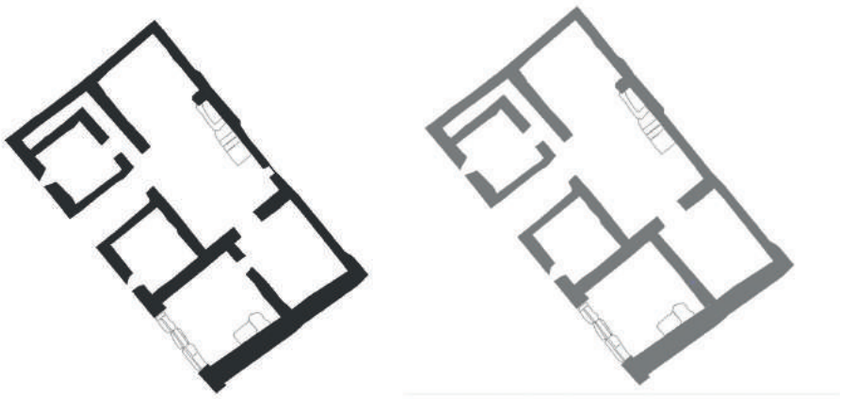

Fig. 12. Vectorisation and visualisation of the plan of the House of Tofelanus Valens with its different phases and changes in the access points between the rooms

Since there is no evidence (e.g., a proper passage) for the connection between the House and nearby Casa del Torello, it is not possible to postulate a direct dependency with it. Further 3D digital analysis of the neighbouring dwelling may provide new data useful for interpretation.

The study demonstrated that the use of digital technologies and 3D models helps archaeologists analyse sites, ancient architecture, and buildings virtually. These methods also confirm or reject interpretation of the past with a higher level of reliability and, possibly, provide new insights.

The digital documentation of the insula enabled creating 3D geometric accurate models of these complex structures. These models could then be used to better analyse them through the use of powerful digital tools able to highlight some features not easily observable with the naked eye.

[39] At the moment the vector analysis has been performed only in 2D, but the further step should involve elaboration of a 3D GIS in order to visualise all the temporal and constructive phases identified during the analysis of the building in the third dimension.

[40] Van Nes 2011, p. 106.

Consequently, they provide a comprehensive and holistic view of the area. The digital instruments can be used for several purposes: documentation, preservation, analysis, and interpretation, even in a collaborative virtual environment. The recent pandemic situation made it particularly clear that there is an urgent need for alternative solutions responding to the inaccessibility of museum collections, archives, and sites necessary for carrying out archaeological research. In this context, 3D digital replicas can be an immediate and precise solution to the issue, providing scholars with an opportunity to study the material in an enhanced way, not *in situ* but in a virtual environment that accurately reproduces the real one.

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