The virtual reality digital model of the Villa of the Papyri project

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The virtual reality digital model of the Villa of the Papyri project has been developed over the past four years at the UCLA Cultural Virtual Reality Laboratory (CVRLab). It demonstrates how virtual reality models may be employed to document and investigate archaeological sites as well as to present hypothetical reconstructions that may serve as virtual restoration proposals of architectural monuments. The aim of the project is threefold: 1) to create a digital architectural model of the Villa of the Papyri that incorporates both the architectural structures known from the 18th century as well as those found in recent excavations, 2) to present a virtual reality reconstruction of the architecture of the Villa that distinguishes between the structures known from Weber’s plan (1758) and still lay underground, the structures that have been recently unearthed (1994–1998, 2007–), and proposed restorations, and 3) to reincorporate the surviving known fragments of the finds from the Villa, such as wall paintings, mosaics, sculptures and papyri. In addressing these aims, the project will provide an invaluable research and teaching tool for the Villa of the Papyri. This paper presents the evidence, methodology and tools used for the construction of the virtual reality digital model of the Villa of the Papyri.

1 The project has been created with the support of the UCLA Experiential Technologies Center, the Friends of Herculaneum Society, University College London and the Excellence Cluster TOPOI.

2 The photographs of the Villa of the Papyri that are included in the digital model were taken by the author and are published here with the permission of the Ministero per i Beni e le Attività Culturali and the Soprintendenza Speciale per i beni Archeologici di Napoli e Pompei. I would like to thank Antonio De Simone, Maria Paola Guidobaldi and Domenico Esposito for discussing the most recent excavations at the Villa (see De Simone and Guidobaldi in this volume). I am especially grateful to Domenico Esposito for discussing the reconstruction of the Villa of the Papyri.
The Villa of the Papyri and its reconstructions

Discovered and explored through a series of tunnels in the 18th century, the Villa of the Papyri remained effectively unseen until the beginning of the “New Excavations” by Infratecna in the 1990s. The Villa lies beneath about 30 m of consolidated mud, the result of the 79 C.E. eruption, the deposition of material over time and several subsequent eruptions. The original excavations at the Villa started in May 1750 and continued for eleven years until 1761; they were resumed briefly between 1764 and 1765. The 18th-century excavations were conducted by Karl Jakob Weber, the Swiss military engineer in the service of Charles of Bourbon, King of the Two Sicilies. During this period, the Villa was accessed by wells and was excavated systematically through a series of tunnels, which led to the extraordinary finds of the large papyri and sculptural ensembles. On the basis of the tunnels that gave access to the spaces of the Villa, Weber produced a plan in 1758, now in the Archaeological Museum of Naples (see Mattusch in this volume, fig. 5), which was redrawn with annotations of the findings by Comparetti and de Petra in 1883 (see De Simone in this volume, fig. 1). Weber’s plan was our only guide to the Villa until the Infratecna excavation. This period of excavation from 1994–1998 and the most recent excavations by the Archaeological Superintendency of Pompeii (2007–) gave access to the atrium quarter, known from Weber’s plan, as well as areas that were unexplored by the Bourbons – the first and second lower level of the basis villae, just below the atrium quarter, and the lower terrace structures to the south of the atrium quarter – but the entirety of the Villa still remains underground.

The inability to access the Villa of the Papyri combined with the unique character of the finds from the Villa, the papyri and the sculptures, have led to its idealization as the Roman luxury villa par excellence. Scholarship has analyzed the ownership of the Villa, the philosophical affiliations of the owner as well as the ideological connotations.

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3 See De Simone in this volume, 1–8.
4 See De Simone in this volume, 6.
6 CDP, pl. XXIV.
7 See De Simone, and Guidobaldi and Esposito in this volume.
of the sculptural collection. Due to the lack of available information, attempts to reconstruct the architecture of the Villa have been far less numerous. In fact, there have been only two: the Getty Villa by Langdon and Wilson with the advice of Norman Neuerburg (1974) and the Capware reconstruction by Gaetano Capasso (1997). The first one was produced before and the second one after the Infratecna excavations.

The Getty Villa first opened to the public in 1974 (see Lapatin in this volume, fig. 6). It is not surprising that of all the available Roman luxury villas, J. Paul Getty chose to construct a full-scale reconstruction of the Villa of the Papyri in order to house his art collection in Malibu. The possible association with Julius Caesar’s father-in-law, Piso, as well as the spectacular finds of this elusive site appealed greatly to Getty. Furthermore, the fragmented character of the material remains of the Villa of the Papyri allowed for some flexibility in the adaptation of Weber’s plan for the purposes of the Getty Villa as a museum. Without the architectural details, wall paintings or mosaics of the Villa of the Papyri, Norman Neuerburg, the academic advisor to the Getty Villa architects Langdon and Wilson, compiled a list from the pristine examples of Roman art and architecture that were used to fabricate the museum’s environment. The decoration of the Getty is a product of an eclectic selection of the most impressive surviving decoration from houses and public buildings around the Bay of Naples as well as the city of Rome, which in some cases were adjusted to accommodate modern American taste, for example the colour of the wall paintings. Getty’s goal was not to produce an accurate reconstruction of the Villa of the Papyri, but rather to house his collection in what he “felt a good museum should be.”

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9 For the construction history of the Getty Villa see True and Silvetti 2005.
10 See Lapatin in this volume. On the ownership of the Villa see Capasso in this volume.
12 See Lapatin in this volume, 134–135.
13 See Favro in this volume, 166.
14 Gebhard 1974, 57; See in this volume, Lapatin, 130–131, and Favro, 167.
mation on the architecture of the Villa of the Papyri gave an interpretative leeway that was necessary for the adaptation of the Villa into a museum.

The Capware reconstruction of the Villa of the Papyri by Gaetano Capasso and his team was first released in 1997. This digital reconstruction is based on Weber’s plan as well as on the information from the Infratecna excavations and fills in the “blanks” of the unknown areas, such as wall paintings and mosaics, on the basis of the decoration of houses in Pompei and Herculaneum – like the Getty Villa does. Capasso also drew on the Getty Villa itself as is evident from the similarity of the two reconstructions – especially in the appearance of the second floor. Gaetano Capasso created this, as well as other reconstructions of sites around the bay of Naples, in order to appeal to general audiences. To this end, all the Capware reconstructions feature in a touristic movie and book and are presented in real time in the Museo Archeologico Virtuale in Ercolano, a museum designed for their display.

In order to satisfy the purposes of “edutainment,” the Capware reconstruction of the Villa of the Papyri presents a homogenous three-dimensional environment with no differentiation between the existing elements and those added hypothetically.

The virtual reality digital model of the Villa of the Papyri project presented here has a different scope from either the Getty Villa or the Capware reconstruction. The project was created in order to visualize the information that we have about the Villa and provide a virtual reality reconstruction that distinguishes the material remains of the Villa from hypothetical additions. The model incorporates the results from new excavations into Weber’s plan and puts forward one or more restoration proposals of the Villa’s architecture. Hypotheses are necessary in the restoration proposals that are incorporated in three-dimensional reconstructions of archaeological sites, and by putting forward several this project aims at facilitating further research on the Villa. Part of the flex-

16 See also Lapatin in this volume, 137–138.
17 The Museo Archeologico Virtuale in Ercolano which opened on July 8th 2008 presents the reconstruction of the Villa of the Papyri, together with other Capware reconstructions of buildings from Herculaneum and Pompei (www.museomav.it).
18 Vacharopoulou 2005.
ibility of this virtual reality reconstruction is the ability to select among existing state and different restoration proposals. Whereas the previous reconstructions put forth restoration proposals for the missing parts of the decoration in the style of the original, adopting the approach of Viollet-le-Duc, the restoration proposals in this reconstruction do not imitate the missing decoration and feature a uniform colour. Furthermore, two different colours were used to differentiate the parts of the Villa that are known from Weber’s plan and still lie underground from the recently excavated parts of the Villa. In this way, the colour-coding of the model enables one to distinguish between the kind of information that is visualized (fig. 1).

Methodology of the virtual reality digital model of the Villa of the Papyri project

A virtual reconstruction of an archaeological site is based on excavation data, historical sources, comparative studies as well as the modeller’s informed hypotheses (fig. 2). The virtual reality model of the Villa of the Papyri uses the data from the 18th-century excavations, the Infratecna excavation and the recent excavations of the Archaeological Superintendency of Pompeii. The project used MultiGen Creator for the three-dimensional modelling and Adobe Photoshop for two-dimensional image processing of the textures applied to the surfaces of the model, including the images of the fragments of wall painting and mosaic decoration.

The 1883 publication of Weber’s plan by Comparetti and De Petra was used as a basis for the model (fig. 3; See De Simone in this volume, fig. 1). Information provided by the new excavations allowed this plan to be adjusted and enriched. Specifically, the new plan of the atrium quarter was used to correct Weber’s plan (see in this volume, De Simone, fig. 7, and Guidobaldi and Esposito, figs. 1 and 2), and the

19 Viollet-le-Duc 1854, vol. 8, 14–34; see Melucco Vaccaro 1996.
21 CDP.
23 See Guidobaldi and Esposito 2009 and in this volume; and Guidobaldi et al. 2009.
first and second levels of the \emph{basis villae} structures as well as the lower terrace structures (VPSO area) were added (see in this volume, De Simone, figs. 15 and 16, and Guidobaldi and Esposito, figs. 1 and 34). The dimensions of Weber’s plan, which were accurate overall,\textsuperscript{24} were put into scale in relation to the measurements of the new plan of the atrium quarter. In addition, the pathway to the belvedere was given a more westward orientation according to the Infratecna excavation (see De Simone in this volume, cf. figs. 1 and 2). Finally, the information on the heights of the Villa from the Infratecna excavation (see De Simone in this volume, figs. 14 and 25) was used for the heights of the model (fig. 4).

Weber’s excavation notes and annotations to his plan, published in the 1883 publication by Comparetti and De Petra, were used in order to clarify the difficulties of the plan resulting from the simultaneous graphic representation of structures and tunnels. They also allowed allocating the find-spots of the fragments of wall paintings and mosaics that were found and removed in the 18\textsuperscript{th} century.\textsuperscript{25} For the New Excavations of Infratecna the publications of Antonio De Simone and Fabrizio Ruffo were used.\textsuperscript{26} Since the publication of results from the most recent excavations undertaken by the Archaeological Superintendency of Pompeii only appeared at the end of 2009, personal communications with Maria Paola Guidobaldi and Domenico Esposito, as well as their article in this volume, provided information on their findings.\textsuperscript{27} Visits to the site were conducted in summer 2005 with the permission of the Archaeological Superintendency of Pompeii. Photographs of the mosaics and wall painting fragments taken during these visits were used in the model and are published here with the permission of the Ministry of Culture and the Archaeological Superintendency of Pompeii.\textsuperscript{28} For the restoration proposals of the second floor above the atrium quarter as well as of the substructures of the rectangular peristyle facing the seaside, comparisons were made with other luxury houses and villas in Herculaneum, such as the House of the Relief of Telephus, and around the Bay of Naples, Villa Arianna A in Stabiae and Villa A at Torre Annunziata.

\textsuperscript{24} De Simone and Ruffo 1998.
\textsuperscript{25} CDP, 147–294, esp. 223–236.
\textsuperscript{26} See note 22.
\textsuperscript{27} See note 23.
\textsuperscript{28} See note 2.
As there is currently a terminological confusion in the field of visualizations, a definition of the terms used in the virtual reality digital model of the Villa of the Papyri project is necessary. I use the term virtual reality reconstruction to refer to the model of the Villa of the Papyri model as a whole. This term does not differentiate the visualization of the existing structures and wall paintings of the Villa from their hypothetical reconstructions. The term virtual restoration designates the hypothetical reconstructions of the architecture and wall paintings, where restoration is defined as reconstitution of what is proposed to be the original state of the ancient building or decoration. The term virtual restoration is used for the virtually created restoration of objects or structures that are either presented in virtual reality or projected in real-time on real-world objects. The virtual realm of the model enables us to put forth several such restoration proposals, as none of them is invasive to the monument itself, and as such they are non-committal.

Presentation of the model

The model reconstructs and distinguishes the following areas of the Villa of the Papyri: (1) areas known from the 18th-century plan, (2) areas revealed during the new excavations by Infratecnica and the Archaeological Superintendency of Pompeii that are accessible today and (3) restoration proposals (fig. 1). The areas known from the 18th-century plan are indicated by a yellow-beige colour, (a) in the index of figure 1. A brown-beige colour is used for the areas revealed during the new exca-


30 Stubbs 2009, 23–24.

vations, (b) in the index of figure 1. For the restoration proposals of the atrium quarter and the rectangular peristyle a gray colour is used, (c) in the index of figure 1. For the restoration proposals of the second floors above the atrium quarter and above the rooms in between the square and rectangular peristyles the yellow-beige colour of the 18th-century plan was used. As this latter restoration proposal does not feature in the main view of the model but is only shown as one option of the reconstruction of the Villa in the fly-through of the model, this colour was chosen for reasons of homogeneity and readability of the model. For similar reasons, the gray colour used for the restoration proposals of the substructures is also used for the floors in the areas of the square and rectangular peristyles. The aforementioned colour-coding choices were made in order to satisfy two goals: on the one hand, to create a reconstruction that makes as clear as possible what is reconstructed from the archaeological evidence and what is projected from the evidence in the form of restoration proposal and, on the other, to offer a reconstruction that is comprehensible as a three-dimensional building and it is not overly schematic. Finally, coloured walls occur only in two cases in which archaeological evidence indicates their existence: first, the inner walls of the natatio of the lower terrace and, second, the short wall of the long promenade that is adjacent to the southwest side of the rectangular peristyle.

The model gathers all the surviving fragments of wall painting and mosaic decoration from the Villa, both the ones found in the 18th century and in the recent excavations by Infratecna and the Archeological Superintendency of Pompeii (figs. 5 and 6). The mosaics and wall paintings found during the new excavations as well as those found during the 18th century have been placed in their original locations, for example the mosaic and fragment of megalography in room (i) (fig. 7; see also Moormann in this volume, fig. 9) and the mosaic in room “XVI” in Weber’s plan (fig. 8). The fragments of wall paintings found in the 18th-century excavations were only schematically noted on Weber’s plan. The Latin numbers and letters on Weber’s plan indicate commentaries in his excavation notes where he lists the finds (sculptures, papyri, mosaics and fragments of wall paintings) of a given area over time. For example, in the atrium area, “XIII” was used to indicate the location of

32 CDP, 224, “XVI.”
33 CDP, 221–224.
the fragment of wall painting NM 8759 found on 16 June 1754\textsuperscript{34} as well as two other fragments of wall paintings found on 23 June 1754 that have no inventory numbers,\textsuperscript{35} and “XI” was used to indicate the location of the fragment of wall painting NM 8548 found on 10 March 1754.\textsuperscript{36} These annotations do not indicate the exact find-spots of the fragments of wall paintings. The fragments of wall paintings have been placed in the model at the points where their corresponding annotations occur on Weber’s plan, since these are the approximate “find-spots” for which we have evidence (fig. 9; cf. fig. 6).

The placing of the surviving fragments of wall paintings and mosaics on their exact or approximate locations aims at facilitating research on the Villa’s wall painting and mosaic decoration. One of the options of the model is to switch between existing state and restoration proposals, such as the one of the wall paintings of ala (e) by Moormann (fig. 10; see Moormann in this volume, fig. 5). The reversibility and easiness of switching between proposals during navigation in the virtual reality model facilitates the presentation of several hypothetical reconstructions of such a nature.

Very little is known about the architectural details of the Villa. In order to reconstruct the Villa’s architecture, comparative material from other luxury villas on the bay of Naples was used as well as architectural details surviving from other buildings of Herculaneum. There is no evidence for the order of the columns of porticoes (a), (u) and (m) of the atrium quarter (see in this volume, De Simone, figs. 7 and 8, Guidobaldi and Esposito, fig. 2). Plain Tuscan columns, similar to the tufa columns incorporated in the south and west façades of the House of the Relief of Telephus in Herculaneum, were produced for these porticoes. The surviving footprints of the columns (fig. 11) were used to adjust the intercolumniations indicated in Weber’s plan. These suggest that a fence or a thin wall – such as the thin walls placed between the columns of porticus 13 and 24 in Villa A at Torre Annunziata – was placed in between the columns, both of which were reconstructed as options in the model (fig. 12).

\textsuperscript{34} CDP, 224, V. Explic. “XIII;” CDP, 282, no. 97; see Moormann in this volume, 73, table 1, no. 3.

\textsuperscript{35} CDP, 224, V. Explic. “XIII;” CDP, 287, nos. 99 and 99b; see Moormann in this volume, 75, table 1, nos. 26 and 27.

\textsuperscript{36} CDP, 224, V. Explic. “XI;” see Moormann in this volume, 73, table 1, no. 1.
The recent investigations by Maria Paola Guidobaldi and Domenico Esposito have given information about the columns of the square peristyle. Their shafts were built in opus testaceum and were coated with white stucco that rendered their fluting. The capitals and bases were made of tufa; the capitals were Ionic and the bases were characterised by the Attic profile. A photograph of the base of a column in the north portico of the square peristyle (see Guidobaldi and Esposito in this volume, fig. 14) was used for the reconstructed bases and shafts of the columns of the square peristyle in the model. The Ionic capitals of the square peristyle are not fully visible. As they bear a strong similarity to the Ionic capitals from the recently re-excavated Basilica in Herculaneum, a photograph of one of the latter was used to reconstruct the capitals of the columns in the square peristyle (fig. 13).

The area of the rectangular peristyle is known only from 18th-century excavations. Weber’s notes indicate that the columns of the rectangular peristyle were stuccoed. Photographs of two different kinds of stuccoed columns with stuccoed Tuscan capitals from Villa A at Torre Annunziata (porticus 40, 33 and 34) were used to reproduce alternative solutions for the columns of the rectangular peristyle in the model, one with incised flattened flutes (porticus 33 and 34) and one that is plain up to 1.20 m and then fluted (porticus 40) (fig. 14).

The reconstruction of the basis villae presents the openings of the rooms of the first lower level, which were exposed during the new excavations (fig. 15; cf. figs. 1, 4 and 12; see in this volume, De Simone, figs. 9–11, Guidobaldi and Esposito, figs. 23, 32 and 33). The first lower level of the basis villae is presented in brown-beige colour in the model. Below this first lower level the façade continues for another level presented in gray colour in the model, to indicate the second lower level of the basis villae whose existence is documented by Guidobaldi and Esposito but is not yet excavated. Two rows of large windows found at the west end of the façade (see in this volume, De Simone, fig. 13, Guidobaldi and Esposito, fig. 32) indicate a 5.50 m high flat roof structure in front of the basis villae. The roof of this structure was at level +6.211 (see De Simone in this volume, fig. 14). The slight

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37 See Guidobaldi and Esposito in this volume, 30.
38 I would like to thank Domenico Esposito for providing images and advising on the reconstruction of the columns of the square peristyle.
39 CDP, 294.
40 See Guidobaldi and Esposito in this volume, 42–44.
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inclination of the structure suggests an apsidal or curvilinear avant-corps. The excavators propose that the two windows indicate a series arranged on two levels that continue around this curvilinear structure. The model visualizes this restoration proposal (figs. 1, 4, 12 and 15).

The reconstruction of the structures of the lower terrace (level +2.30) incorporates the restoration proposal by Guidobaldi and Esposito that the terrace reached the front of the *basis villae*. The remains of the large monumental hall on the lower terrace allow for the front part of the hall to be reconstructed. Guidobaldi and Esposito estimate that the structure was as high as the *basis villae*, reaching the level of the atrium (+11.34). The model proposes that the roof of this hall reached back to a hypothetical terrace in front of the rooms at the south-east of the atrium quarter (fig. 4). Here again the existing structures are presented in brown-beige colour and the hypothetical reconstructed structures in gray.

Two restoration proposals have been created for the façade of the substructures of the rectangular peristyle that forms the continuation of the façade of the *basis villae* (first and second lower levels) to the north-west, for which there is no archaeological evidence. One restoration proposal was formed by comparison to the south-east façade of a projecting structure of the north-west *Insula* of Herculaneum that features two rows of a series of niches (fig. 16; see De Simone in this volume, fig. 5). This projecting structure is part of a large house, comparable to the House of the Relief of Telephus, and is part of the new excavations area to the south-east of the Villa of the Papyri (see De Simone in this volume, fig. 4). A second restoration proposal was formed by comparison to the vaulted substructures of Villa Arianna A and Villa Arianna B in Stabia presenting the façade of the substructures of the rectangular peristyle with two series of vaults (fig. 17).

A restoration proposal has been produced for the second storey above the areas of the atrium quarter and in between the square and rectangular peristyles. Like all the other restoration proposals of the Villa, it can be “switched” on and off during the fly-through the model (fig. 18). No restoration has been proposed for the second storey above the area of the library, room “IV” in Weber’s plan, as the full extent of this area towards the north-east is not known.

41 See Guidobaldi and Esposito in this volume, 43.
Conclusion

By differentiating between the kind of information visualized in the model as well as by providing the option to switch between several architectural and wall painting restoration proposals and their existing state, the virtual reality digital model of the Villa of the Papyri project aims at providing a flexible and adaptable research and teaching tool. In the next stage of the project, the find-spots of the papyri and three-dimensional scans of the sculptures will be added. When this stage is completed a Google Earth KML file of the model, which will enable the three-dimensional model to be launched in Google Earth, will be available through the website of the UCLA Experiential Technologies Center (http://www.etc.ucla.edu/research/projects/projects.htm). This access will allow for a wider audience, of scholars and students at all levels, to use the model for research and to increase information available about the Villa of the Papyri. In the meantime, information on the virtual reality digital model of the Villa of the Papyri project is available online through the same website.

The abundant production of virtual reconstructions in the field of archaeology over the past three decades has led to arguments over the scientific qualities of these reconstructions and their instrumentality in academic research. However, it is by now widely accepted that virtual reality reconstructions can be both accurate as well as instrumental in research. The virtual reality digital model of the Villa of the Papyri project is an example for the application of virtual reconstructions both in the visualization of existing architectural remains as well as in virtual restorations. Restoration, that is an intervention that goes beyond the consolidation and preservation of an architectural structure to propose its original state, has two major disadvantages; first, it is a permanent intervention and, second, it has an impact on the existing architectural remains. In the virtual realm both these physical problems are superseded as several non-invasive restoration proposals can be put forth at the same time. The virtual restorations of the architecture of the Villa of the Papyri supersede an additional obstacle posed by the physical inac-

42 Favro 2006.
43 Favro 2006; Wulf and Riedel 2006; Frischer and Dakouri-Hild (eds.) 2008, especially Frischer, v-xxiv; Barcelò, Forte and Sanders (eds.) 2000. See also the proceedings of the annual CAA (Computer Applications in Archeology) conference: http://www.leidenuniv.nl/CAA/.
cessibility of large part of the Villa. The virtual restorations serve as a mental link between the two kinds of architectural remains of the Villa, those still underground and those unearthed during the recent excavations, that enable us to understand them better. Furthermore, the visual differentiation of the restorations from the existing remains of the Villa as well as the multiple restoration proposals invite us to engage critically with the reconstruction of the Villa. In doing so the reconstruction presented in the virtual reality digital model of the Villa of the Papyri project not only deepens our understanding of the Villa’s existing architectural structures but also sharpens our visual thinking and encourages a critical approach to reconstructions.
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Abbreviations

Antichità 1757–1792
Delle antichità di Ercolano (Naples 1757–1792).

CDP
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Diario di scavo Infratecna
Ufficio Scavi in Ercolano. Diario di scavo Infratecna.

Fonti Ercolano Stabia

Mattusch

NM
National Archaeological Museum, Naples; used with inventory numbers.

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