Chapter 10
3D Digital Models for Scientific Purpose: Between Archaeological Heritage and Reverse Modelling

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ABSTRACT
Reality-based digital models assist in the achievement of accurate analysis of historical buildings as well as archaeological sites and, more in general, of monuments featuring more or less complex forms. Their reliability is particularly useful when the state of conservation of masonries and vaults has been altered due to deterioration phenomena or as a consequence of incorrect interventions. In these cases, a highly detailed “digital copy” of the ancient constructions, if correctly observed via reverse modelling applications, can provide useful indications for an accurate and scientifically-based digital reconstruction. The Octagonal Hall of Small Baths at Hadrian’s Villa, with its daring design of vaults and audacious building techniques, was chosen to test several interpretation techniques based on the customization of contemporary reverse modelling procedures integrated with standard protocols of design analysis and archaeological investigation.

INTRODUCTION
In this chapter, a number of digital tools for archaeological investigation will be taken into consideration. Theoretical and practical aspects concerning how to use reality-based models will be discussed so to define the key topics of a procedure to interpret complex and partially collapsed buildings and their design principles, such as those concerning ancient cupolas. The case study that was chosen is the

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Octagonal Hall (Figure 1), which is part of the so-called Small Baths, an important monument partially in ruins located in the archaeological site of Hadrian’s Villa.

The analysis of a mesh model from the laser scanner survey provided a reconstruction of the vault: its exceptional shape is part of a sort of “catalogue” including the architectural experiments which were developed during Hadrian’s age and that can be seen in Tivoli (Rome) and Baia (Naples), particularly in thermal buildings.

Their uniqueness is the reason why they play a special role in the history of architecture and construction: “Daring experiments in the design and construction techniques of its buildings turned the site into a vast playground, with structures that had no equal in the ancient word” (Opper, 2008, p. 132). For this reason a typological comparison is hard to carry out; furthermore the main Small Baths’ dome structure presents more problems regarding its state of conservation: in fact, vast areas of the roofing were damaged and altered by both natural events and human interventions (restorations, reuse, spoliation, etc.). Restorations of such unique structures, that were carried out without a careful and complete survey of the masonry and concrete vaults, now harden current-day research, due to the presence of original and altered parts (Figure 2).

In order to provide the elements for a reliable virtual reconstruction of the baths’ central dome, a digital model of the Octagonal Hall was methodically analysed in search of the advanced design used by ancient architects to achieve such unique structures.

Hadrian’s Villa is the product of less than twenty years of building activity; in spite of it being built in such a short stretch of time, it is likely that originally the compound covered 120 hectares at least: in terms of function and use, the imperial mansion appeared like a mixture of Versailles and the picturesque informality of a vast English country house (Opper, 2008, p. 240).

*Figure 1. The unique shape of Small Baths’ Octagonal Hall
Source: Photo by Filippo Fantini*
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