Multidisciplinary analysis: the Early Christian complex in Cimitile (Italy)
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1. Introduction on place and its history
The basilica complex of Cimitile is located north of Nola, near Naples. The complex is famous for the presence of the martyr-St. Felice sanctuary. The archaeological site consists of seven buildings of worship of early Christian and medieval ages, dedicated to Saints Felice, Calionio, Stefano, Tommaso and Giovanni, to Saints Martyrs and to Madonna degli Angeli, then S. Felice parish church, which was built between the late eighteenth and early nineteenth century.
In the territory of Cimitile there was a necropolis, where it was placed the St. Felice tomb of the second half of the third century. Around the tomb of the saint were built the sanctuary and a village.
In the late fourth and early fifth century, Meropio Pontius Anicio Paulino - Roman aristocrat, native of Gaul - restored the western basilica, built buildings for the monastic community, and restored the aqueduct from Avella. Furthermore, he built a new and great basilica (the basilica nova).
At the beginning of the sixth century, the basilica complex was hit by the disastrous flood that followed the eruption of Vesuvius. Instead, during the middle of the sixth century was built a new church dedicated to the Apostle Tommaso. Enlargements restorations and reconstructions were realized until the end of the eighteenth century, when the S. Felice basilica was restored on the initiative of Girolamo Albertini, Prince of Cimitile, and was built the new St. Felice parish.
The S. Felice basilica, then, is at the core of the Cimitile sanctuary cemetery; it was, for a long time, the cathedral of Nola before adopting the function of Cimitile parish. This function was held until the end of the eighteenth century. Until 1955 the building has preserved the altar in which, in the early Middle Ages, the remains of the saint were translated from the original tomb.
In the nineteenth century, the monumental complex was left in a state of neglect. A slow but gradual recovery of the sanctuary began thanks to restoration and excavations undertaken between the late nineteenth and early twentieth century.
The first systematic investigations began in 1931, when Gino Chierici, superintendent of medieval and modern art of Campania, began the excavation of the basilica nova. The investigation was continued by Benedetto Civiletti, an official of the same Superintendence.
Unfortunately, during Chierici’s research were realized a lot of demolition and these caused data losing about the archaeological stratification, making it impossible for the dating of structures. In the fifties of the twentieth century, the works concerned especially St. Felice basilica. In this period Chierici proce-
ed with greater care, noting in his notebook-paper the main stratigraphic relationships between structures and also creating a large graphic and photographic documentation.

In the years 1963-67, works concerned the St. Tommaso and St. Stefano basilicas. Since 1988, excavations were coordinated by Letizia Pani Ermini. The researcher, thanks to the investigations carried out, was able to relate the St. Stefano Basilica west alluvial layers to those described in an epistle of Theoretical Cassiodorus in the sixth century. Therefore, the mud presence made it possible to place the St. Stefano basilica’s construction before the flood and the St. Tommaso one after this event. The flood of the early sixth century affected also the rooms of basilica nova, in particular, the part under the left aisle of the building, which was used in funerary purpose.

2. The project
2.1. State of art
Interest in different techniques and methods of digital survey and three-dimensional modeling (photogrammetry and laser scanning) in the field of archaeology is increasing. That is emphasised by their growing demand and increasingly frequent use aimed to obtain forms of recording and digital storage at different levels of scale and resolution. This evidence arises from the necessity of adopting a common language for experts in 3D data management and archaeologists with the principal aim being the understanding of each other’s requirements and sharing of the purposes of the project [M. Russo, F. Remondino, G. Guidi, 2011, 198]. It has become apparent that this technique makes a positive contribution to scientific historical research especially for interpretation of the results. Despite the fact that to date there is no software specifically dedicated to the philological reconstruction of the past or historical applications, with their introduction in the areas of historical research technologies, 3D representations have revealed themselves as an extremely effective dialogue instrument between history and technique allowing quick bidirectional communication of complex concepts without the need of any further simplification.

2.2. Objectives
The aim of the work here reported, which use the complex of Cimitile as case study of reference, is the definition of a precise methodology to obtain final output (plans, sections, elevations, photo-plans), useful in the field of archaeology and restoration to realized at first material drawings and then the study of stratigraphy focused on verifying of hypotheses about building/site develop-
ment to deeply understand them. The use of this methodology should make it possible to replace conventional approach, linked to techniques of direct survey, because it allows to work more speedily, with high degree of accuracy and resolution and to achieve better results in terms of geometric and colorimetric information.

2.3. The survey
The entire archaeological area was surveyed with a laser scanning technology and then realized a three-dimensional model. In particular, the survey of all internal and external surfaces of the complex was made using three different types of phase-based (PB) 3D laser scanners. The archaeological plan was examined in order to suggest a first optimized network of scan positions, trying both to minimize the acquisition time and to consider all the morphological characteristics of the architecture of the site. The 3D survey of the area was planned following three different steps corresponding to three days of work. In the first one all external surfaces were acquired, in the second one all interior surfaces, during the third day the survey of the shadow areas, verified in laboratory, was carried out.

3. Results
3.1. Comparison of plans
In this study, virtual reconstruction was also a tool to validate the hypothesis about the position of each basilica in the archaeological area. The last surveys carried out into the site, in fact, were realized with equipment that cannot be compared with the today’s technology therefore without the respective advant-

Table 1 Step 1 - Survey set-up; Table 2 Step 2 - Survey set-up; Table 3 Step 3 - Survey set-up
Fig. 5 - Plans of the Early Christian complex of Cimitile

Fig. 6 - Comparison with the plan of G. Chierici; Fig. 7 - Comparison with the plan of A. Mercogliano

Fig. 8 - Comparison with the plan of T. Lehmann; Fig. 9 - Comparison with the plan of C. Ebanista
A plan of the area was obtained and compared with those done by some experts who worked on Cimitile during the last century. In particular the purpose of the comparison was analyse the accuracy of traditional survey techniques with laser scanning ones, with particular attention to the level of detail, the topographic position of building and at last possible deviations. Comparative analyses show that differences concern specially the positions of the Basilica of St. Stefano and the Basilica of St. Tommaso.

3.2. Final output
The following step was an accurate study of the elevations and sections, the
Fig. 12 - One of the final outputs obtained by the 3D model after the texture mapping (Basilica of St. Stefano)

Fig. 13 - Materic survey of a section of the Basilica of St. Stefano (developed by A. Mariniello)
second obtained by cutting the 3D model with fitting plane. Then the process of texture mapping allows us to add detailed information about the materials and some other formal details on the digital model without complicate geometric complexity of it. This result was obtained projecting on the model images of the texture [Barba et al., 2011, 215]. Combinations of various methods and software are used and the most common output in this case has a form of 2D data and was used to realize material drawing of walls of the basilicas. Moreover, a Digital Elevation Model (DEM) of the archaeological area of Cimitile was realized. In this DEM each point has a value corresponding to its elevation towards a reference plan.

**Conclusion**
This paper has discussed a method for the virtual reconstruction and representation of an archaeological site. Such method and its procedures were tested on the Early Christian complex in Cimitile in order to demonstrate how 3D modeling can be an effective support to archaeological studies. It engages a highly interdisciplinary group of specialists combining competences of each team, in order to propose a new kind of analysis of historical heritage. This solution could be applied to a great number of sites that deserve careful consideration and increased attention, through their investigation up to actions, when necessary, of restoration. The essential condition for guarantee the future of this heritage is, without any doubts, its knowledge.

**References**
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