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REVIVING THE PAST: UTILIZING THE EXTENDED MATRIX TOOL FOR DEACON THOMAS DAYR VIRTUAL RECONSTRUCTION

1. Introduction

The Mount Nebo hill in Jordan is traditionally known as the place of Moses' death. But it is also characterized by the presence of a large number of archaeological sites with a long occupational history, starting in the Early Bronze Age I and extending until the Ottoman period. Nevertheless, today only the Moses Memorial Church, which sits on the Siyagha hill and the Church of SS Lot and Procopius at Kh. al-Mukhayyat have been restored and conserved.

The PhD project presented here, carried out at the University of Perugia (Department of Humanistic Studies) and financed by The Italian Ministry for Universities and Research (MUR) within the framework of the national PON, follows up on an idea already proposed in 1993 by Franciscan father M. Piccirillo and G. Palumbo. The latter had planned an archaeological park around Mt. Nebo to protect the local archaeological contexts (Piccirillo, Palumbo 1993). Unfortunately, the author's recent survey revealed that many of these important archaeological sites continue to deteriorate: there is evidence of vandalism (such as the graffiti on the restored walls of the Dayr of Deacon Thomas), clandestine excavation (many sites reveal multiple holes, such as those at the top of Tell al-Mashhad), but also mechanical destruction, as recently documented at al-Kanisah Monastery and at the Dolmen Fields. In other cases, lack of maintenance has led to the deterioration of the structures (as in the Monastery of the Theotokos).

The aim of this PhD project is to create a tool that can help to preserve the memory of these sites and improve their understanding by reconstructing them in a virtual archaeological park, where users can visit the different phases of the various monuments. The goal is to create virtual reconstructions that are not only beautiful and appealing, as is often the case in the field of cultural heritage and museology, but also philologically correct, with a reconstructive process that can be verified and updated. The Extended Matrix tool and its formal language, developed and tested by the CNR-ISPC Digital Heritage Innovation Lab (DHILab), meet this need, and form the basis for all reconstructions in the park.

2. Philological reconstruction of Deacon Thomas' Dayr

The Deacon Thomas' Dayr is located at the foot of Siyagha hill, in the fertile valley of the springs of the Uyun Musa (Fig. 1). This church was

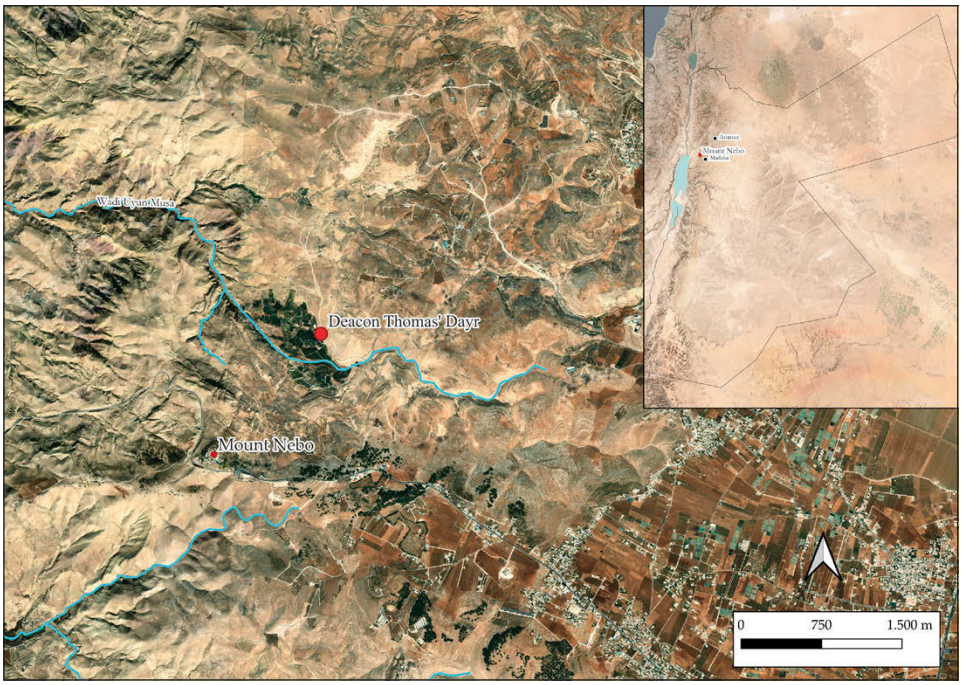

Fig. 1 – The location of Deacon Thomas Dayr in relation to Siyagha hill (Mount Nebo) (made by QGIS).

identified in the 1930s and was excavated only between 1986-1989 by the Studium Biblicum Franciscanum. According to archaeological and stylistic data, the church was built in the first half of the VI century AD and abandoned in the Umayyad period (VIII century AD), but it must have already undergone at least three phases with substantial interventions in the second half of the VI century (Piccirillo 1990, 1998).

In this specific case, the advantages of a philologically correct three-dimensional reconstruction would be multiple. In fact, a thorough re-reading of the monument is necessary to propose a philological reconstruction based on the published excavation data in order to restore the original appearance of the church, which is very different from the current restoration. In particular, the use of the Extended Matrix tools makes it possible to propose reconstructive hypotheses even on the least preserved elements, while highlighting the uncertainty of the available data using colours. From a scientific point of view, this tool will allow the reconstruction process behind each element of the church to be made explicit. It will ensure a 'transparent' reconstruction linked to archaeological data (Demetrescu 2018), by showing the sources used to

reconstruct each element. It would also be possible to (virtually) restore the magnificent mosaics that were part of the church's decoration in antiquity. From a touristic point of view, this tool will allow the site to 'speak'. It will be the starting point for visitors to understand its original appearance in the different periods of its life. The project is divided into three main steps to create a virtual model correctly.

2.1 '*List of source*' *creation*

The list of sources is based on a bibliographical survey of Deacon Thomas Dayr and contains all the useful sources selected for the reconstruction of the architectural and liturgical furnishings. This list also includes comparisons with other sites of the same chronological period and geographical area, as well as general information on ecclesiastical architecture, useful for the development of virtual reconstruction hypotheses. The creation of a realistic model, a digital replica of the Dayr, using photogrammetry with a camera positioned on a topographical pole, followed by processing with Metashape pro, was also fundamental in this phase: this made it possible to record the condition of the site and its current state of conservation (Fig. 2, 1).

The plan and the section, both drawn during the excavation of 1986-1990 and published by M. Piccirillo (1990, 1998), were the two main sources used for the reconstruction. In fact, a comparison of the reality-based model with a scale plan revealed a small discrepancy between the position of the eastern perimeter wall and the internal walls defining the rooms on the side of the presbytery, as well as the position of the southern rooms. As a result of the recent restoration work, the layout of the building may have changed slightly. For this reason, it was decided to base the virtual reconstruction on the plan. In addition, this source makes it possible to identify the presence of many elements that are no longer visible today, such as the mosaics floor; the bases of the pillars and the pillars themselves; the steps leading to the presbytery; the recesses traces of the central chancel screen and the lateral aisle's chancel screen, the pillars of the arch leading to the presbytery, the bases of the altar colonnettes, and thresholds of the door, among others. This was one of the most important documents for the repositioning of the aforementioned elements and their reconstruction in the correct metric system.

Further information was found in the excavation photographs, both in black and white and in colour, and in the excavation reports, which often specify the elevation of each element (e.g., the elevation of pillars), the materials of the liturgical furnishings or architectural elements and their dimensions or decoration. These reports also suggest various reconstructive hypotheses: the existence of arches on the pillars, justified by the discovery of an arch impost, or the existence of an entrance arch to the presbytery, based on the discovery of a series of collapsed stones on the steps of a staircase (Piccirillo 1998).

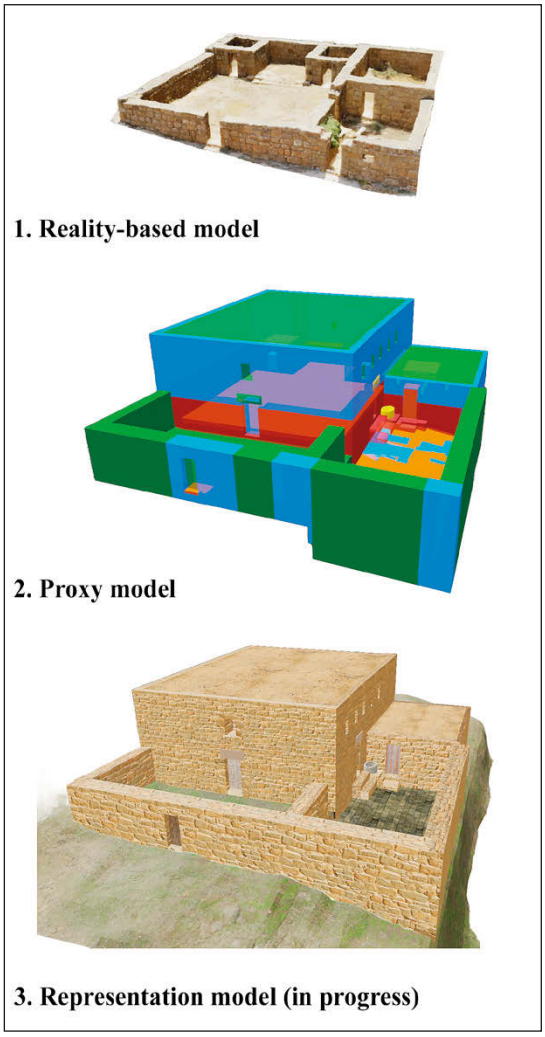

Fig. 2 – Deacon Thomas Dayr virtual reconstruction different levels.

The presence of an earthen roof is hypothesised by the layer of yellow earth found directly over the mosaic (Alliata 1990). All these documents have been entered into an Excel database 'list of sources' consisting of several fields (Demetrescu, Ferdani 2021). Each source is identified by a different field: a unique ID, a description, a link to the bibliography and, finally, the properties (e.g., elevation, dimension, material, style) that the source can validate.

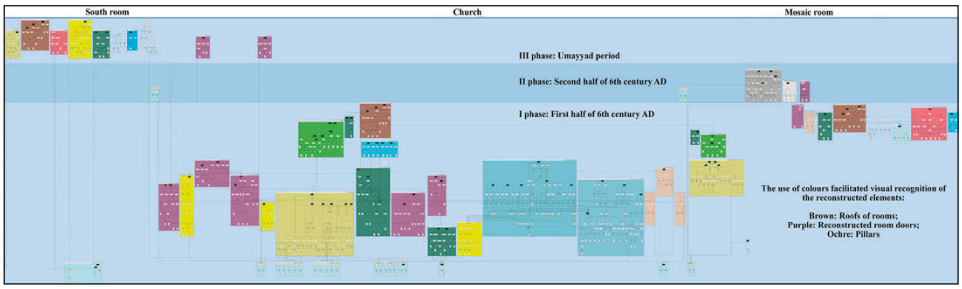

Fig. 3 – Deacon Thomas Dayr Extended Matrix created with yEd graph editor 1.4.

2.2 *Data management and analysis*

The second step was to create an EM graph in which all SUs (Stratigraphic Units) and all USVs (Virtual Stratigraphic Units) were inserted in yEd graph editor 1.4 (Fig. 3). These were linked according to Harry's Matrix rules (Demetrescu 2015) and their properties (e.g., dimensions; heights; material; style) were made explicit with reference to the document used (Demetrescu, Fanini 2017; Demetrescu 2018). This was done by tracing three main phases, corresponding to the rows of different shades of blue on which the extended matrix graph is divided. The most recent is the Umayyad period of abandonment and functional change of some rooms, the second dates to second half of the 6th century, in which some elements typical of this period were added, while the first phase of construction took place in the first half of the 6th century. The graph is very complex and typological groupings have been used to make it easier to read. A different colour has been used for each grouping, making it possible to immediately identify the position of the element to be reconstructed (Fig. 3). This EM graph can be imported into the Blender software via an add-on: 'EM-blender-tools' (Demetrescu 2023). It will then be possible to directly construct the proxy model of the extant structure.

2.3 *Interpretation proxy model elaboration*

The reconstruction, on a geometric level, of most of the elements is based on what are known in the language of the Extended Matrix as USMs: elements for which there is some information from excavation data, although many of them are no longer visible (Demetrescu 2015). Thanks to previous documentation, it has been possible to obtain dimensions, elevations, and information about materials and decoration which allow the identification of many elements of the height level of confidence (Fig. 2). Unfortunately, the excavation reports date from the last half of the XX century and are therefore incomplete and do not consider the stratigraphic data. This situation

presented a problem for the proxy modelling, especially when combined with the poor preservation of the wall, the limits, thickness and construction phases of which are not know precisely, as is the case, in particular, for the rooms to the south of the church.

Specifically, the most difficult part was the reconstruction of the hypothetical elevation of the upper parts, such as those of the arches, the wall above them and the roof. In fact, although many churches have been discovered over time in Jordan, very few have been preserved in their entirety. The most important of these can be found in the north of Jordan, at Umm el-Jimal and in Syria. For these sites there are detailed plans and sections, often with reconstructive hypotheses, mainly by H.C. Butler in 1913 and G. Tchalenko in 1979. However, they were made with older surveying techniques than those used today and are probably less accurate. Nevertheless, they remain the fundamental basis for analysing these monuments. In the case of Deacon Thomas Dayr, for example, a peculiar situation emerged when reconstructing the elevation of the pillars that supported the vaulting. In fact, in the surrounding area, especially in Umm al Rasas, several churches with pillars can be identified, but the pillars were placed at a greater distance, often corresponding to their elevation dimension. In the case of Dayr, the pillars stood very close together compared to churches with columns. Following the Byzantine churches found in Umm al-Jimal and Syria (Butler 1913), where the elevation of the pillars is 6 times the shaft, this measure was applied to the pillars, resulting in a measure equal to that of the church in Berriš North, Syria (Fig. 4), which also has a plan with very similar dimensions (Tchalenko 1979).

Another peculiar element where the reconstruction was based on comparisons was the identification of the type of roof. In fact, although there are many churches in the region with the standard gabled form with a clerestory, it

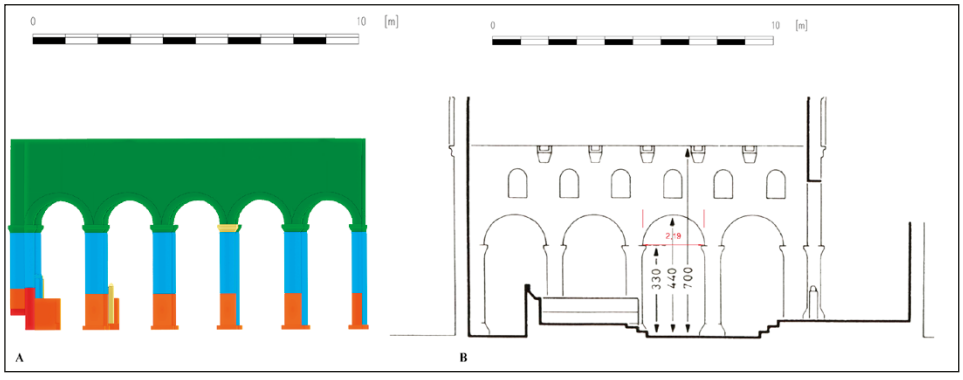

Fig. 4 – Comparison of interior dimensions of the church at Berriš North, Syria (from Tchalenko 1979) with Deacon Thomas Dayr's proposed reconstruction.

is impossible to hypothesise its presence on the site. In fact, in this excavation, as far as the documentation goes, there does not seem to be any evidence of tiles, suggesting that the roof was not a pitched roof. Their absence suggests a flat roof, but stone beams, common at other sites in the region to support the earthen roof, were always documented by the Franciscans who carried out the excavations in Jordan.

A hypothesis might be that the tiles were removed after abandonment to be reused in other buildings, but the same argument could be made for wooden beams, which were much more valuable. It is therefore possible to hypothesise a flat earthen roof over wooden beams. Unfortunately, it is difficult to find evidence of this in the excavation reports, because the stratigraphic sequence excavated inside the church and in the rooms to the south has not been published, and it is therefore impossible to trace the presence of evidence of decomposition of wooden beams or related evidence such as

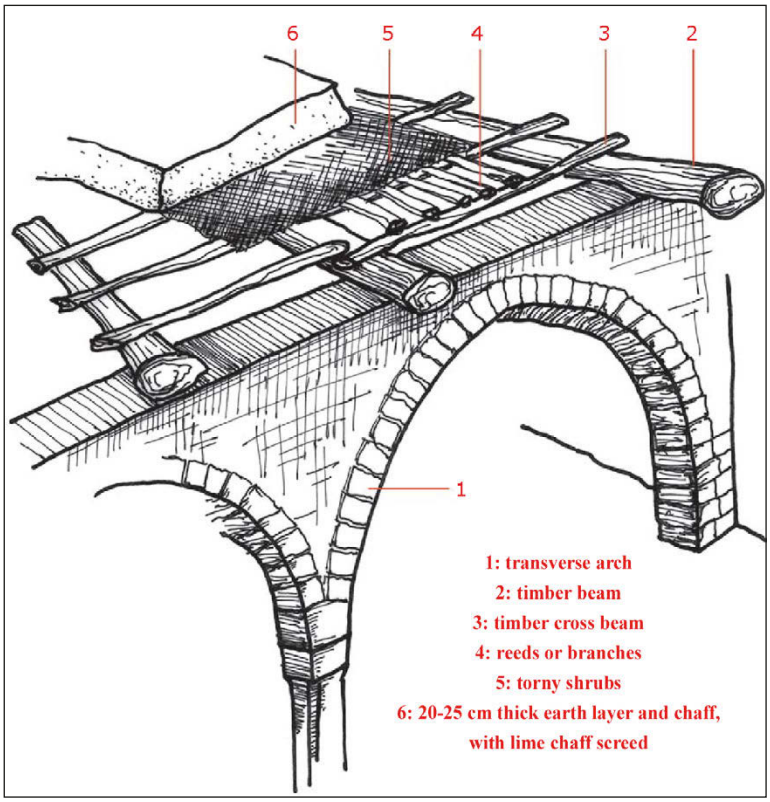

Fig. 5 – Earthen roof construction layers from a traditional house (from Helmedag, Jäger 2012).

iron nails, coals and ash piles. The only information available regards a layer of yellow earth directly over the mosaic, mentioned in the excavation reports (Alliata 1990), which could be the traces resulting from the collapse of this roof. Another layer of yellow earth directly above the church pavement was also found in the C101 church at Humayma in Jordan and this was interpreted as a flat roof with packed earth over wooden beams (Schick 2013). There is not much evidence of this type of covering in scientific publications, however, the existence of earthen roofs is assumed in the publication by A. Michel (2001), in her general considerations on the roofs of Jordanian churches. Nevertheless, it highlights the difficulty of identifying its traces on an archaeological level (Michel 2001). In this publication Michel identifies the same construction technique in some XX century houses in Madaba, where wooden beams resting on stone arches support a mixture of earth and straw. Other examples have also been found in traditional architecture in rural areas in Syria. Structural remains of a formerly earth-covered rafted ceiling on wooden pillars are visible, for example, at Muqabara in Syria. Several layers have been identified in the construction of roofs in both wooden and stone architecture. It is possible to see the sequence of the layers that are part of the typical roof of these traditional houses in the publication by Helmedag and Jager in which the first layer is made by larger wooden beams (Fig. 5), laid on top of the transverse arches, on which the wooden cross beams are placed, followed by reeds or branches. A layer of thorny shrubs in damp earth is placed on top of these layers, followed by a 20-25 cm layer of earth and chaff, finished with a lime-chaff screed (Helmedag, Jäger 2012).

3. Conclusion and future works

The use of the EM tool proved to be useful for two reasons: a purely scientific standpoint, in which it was possible to follow the author's mental process for each element that was reconstructed, and to verify the sources used. On the other hand, the tool allows the general public to understand the probable original appearance of this monument before the current restoration. Re-examining the publications of the 1986-1989 excavations has made it possible to compare this site with other recently excavated sites in Jordan. This has provided support for hypotheses that may have been less convincing at the time due to a lack of data.

The goal of this project is to produce a representational model based on the edited excavation data, in order to create an immersive and philologically correct virtual model. It will also be possible to see the three different phases of construction and abandonment, during which passages were blocked off and the use of some rooms changed. The future development aims to make the scene in which the church is placed more evocative and more realistic with

the effect of light. The ancient mosaics will also be repositioned. Subsequently, the entire reconstruction process will be made available to the scientific community. It will be published as an open source framework that guarantees maximum sustainability and re-usability through the Zenodo platform, indexed by Open Aire, maintained by CERN and funded by the European Community. In terms of tourism, this project can also be developed into an interactive web application, following the idea of a virtual archaeological park, or used in a physical museum as an integral part of the exhibition.

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ABSTRACT

The use of the Extended Matrix in the planning of the Mount Nebo virtual archaeological park allows for the creation of virtual models. The models facilitate the rediscovery and understanding of sites in the surroundings of the Moses Memorial on Mount Nebo that are difficult for tourists to access, ensuring the virtual preservation and memory of these sites. The use of the Extended Matrix as the basis for virtual reconstructions guarantees a philologically correct reconstruction based on reliable sources. The possibility of verifying the sources used and the reconstructive process of the author, at any time, ensures a transparent reconstruction. Sharing this data also makes it possible to have access to large databases that can be implemented and modified over time to keep them up to date.