HBIM to recovery the trulli in Apulia (Southern Italy)

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Abstract. This contribution describes an ongoing research conducted by the ISPC - CNR of Lecce, relating to the implementation of a project with BIM software and related to the recovery of n. 3 *trulli* located in Apulia in the countryside of Martina Franca (Taranto - Southern Italy). Research aimed at the restoration and related scheduled maintenance of the same.
HBIM (Historical or Heritage Building Information Modeling) is a process applied to existing buildings that increases the potential of the BIM method, extending its use to the creation of models of existing buildings. The technologies of digital photogrammetry and laser scanner detection are used to collect information in the HBIM, which also thanks to the possibility of associating geometric information with images, make it possible to obtain a virtual model faithful to reality. From the processing based on the survey data, we then move on to the creation of libraries with parametric objects that represent all the components of the artifact. The step to get to the true digitization of the model consists in the reconstruction of the BIM model of what was detected. In fact, from a three-dimensional surface that depicts the surveyed work it is necessary to create a parametric 3D model. Through the merger of the data, an HBIM model is thus constructed that contains all the information relating to the history of the building, from which the production of technical drawings, 3D documentation, sections, details and schedules will derive. In conclusion, the geometric models thus obtained, through the surveys, must constitute indexes of contents, with data that can be consulted regarding the history, technical characteristics of the individual components, the state of deterioration of the work, in short, a range of information, all included in the associated database, and therefore usable at multiple levels of interest.

1. Il trullo

The constructive articulation architectural model of the *trullo* has the genetic characteristic to have two independent spatial structures, the first one determines the internal volume, the other one defines the external volume (Fig. 1). The two structures, in addition to being autonomous, also differ in their geometric shape as well as in the size of the stones with which they are both made. In most cases it is limestone, which has been used in its wide range of sizes and thicknesses, without the use of mortars or cements, but taking into account the own weight, the mutual contrast and the stone wedges inserted in the interstices. Essentially, the same construction methods used in the construction of the Apulian dry stone walls are found and, in the same way, the material used was, for the most part, recovered within the agricultural area where the *trullo* was built, both because it constituted an encumbrance to the operations agricultural, either because the orographic support admitted it as an outcropping stratification. In the construction of the *trullo* the selection and differentiation of the sizes and thicknesses of the stone is due to specific purposes, the ashlars that had larger dimensions were used to form the edges of the lower part of the external structure, as well as the cantonals and the architraves of doors and windows, medium-sized ashlars were used to shape the wall faces, medium-thick slabs (chianche) were used to make the floors, thin slabs (chiancarelle) were used for roofing (Fig. 2,3).

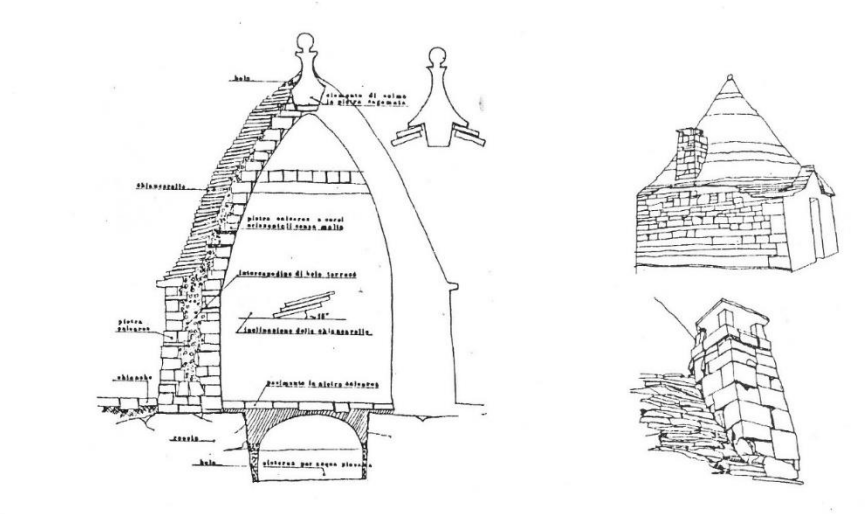

Fig. 1. The two spatial structures of the *trullo*, external and internal.

Fig. 2. Main prospect of the *trulli*

Fig. 3. Back prospect of the *trullo*

2. Structure of the BIM

First, it must be emphasized that in order for a BIM recovery intervention to be as respectful as possible of the architectural and structural characteristics of a building, it is necessary to acquire a large number of specific data and information. Upstream of the project, it is essential to carry out an accurate historical, geometric and material investigation of the artifact, without which it would not be possible to plan subsequent recovery interventions. A phase that consists in the survey and subsequent return of all the information acquired. In a second phase, these data will provide an adequate knowledge base to carry out the necessary diagnostic analyzes on the building and highlight both the details of the contents of the recovery intervention and the subsequent maintenance plan. The technologies of digital photogrammetry and laser scanner detection are used to collect information in the HBIM which, thanks to the possibility of associating geometric information with images, make it possible to obtain a virtual model that is particularly faithful to reality. It should be noted that the cloud of points obtained is of fundamental support to modeling, especially in historic buildings, as it is characterized by a complexity of elements, shapes and construction details. From the processing based on the survey data, we then move on to the creation of libraries with parametric objects that represent the components of the building. In practice, starting from unstructured data, such as the point cloud, the software generates structured data, the mesh, or texture. In reality, from a myriad of points we arrive at the definition of surfaces. Basically, with the creation of the mesh, through specific software, we move from a set of points to a continuous surface that makes up the 3D model (Fig. 4). The step to get to the true digitization of the model consists in the reconstruction of the BIM model of what was detected. In fact, from a three-dimensional surface, consisting of the texture, which depicts the surveyed work, it is necessary to create a parametric 3D model. Through the fusion of the data, an HBIM model is thus built, which contains all the information relating to the history of the product, from which the production of technical drawings,

3D documentation, sections, details and schedules will derive. In practice, a model that must give the possibility to access all the specific information of every single architectural detail of the building.

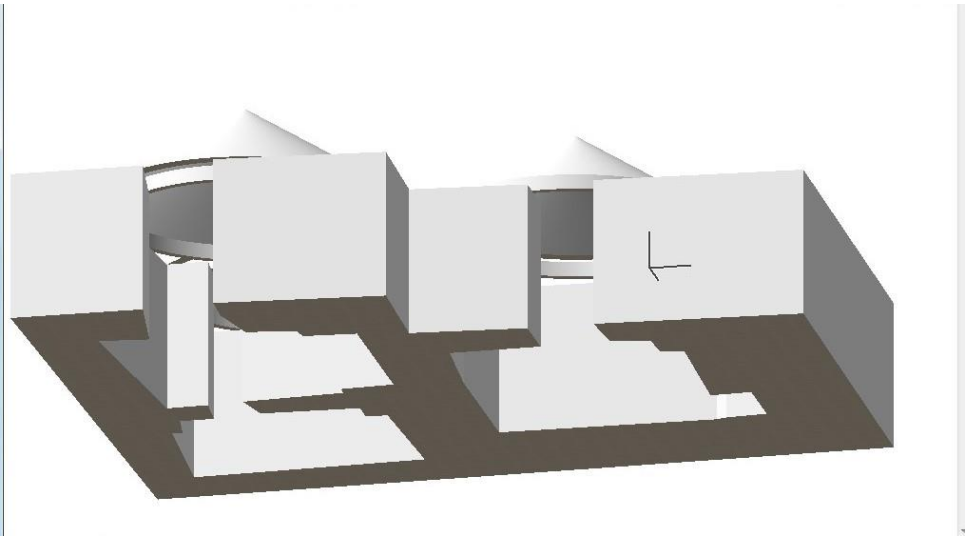

Fig. 4. Screenshot of a work session.

3. Conclusions

To conclude, the geometric models obtained through the surveys must constitute indexes of contents, obviously with data that can be consulted regarding the history and technical characteristics of the individual components, the state of degradation of the different parts of the work, the name of the companies that carried out the different interventions over time. A wide range of information, therefore, all inserted in a database, which can always be implemented over time, and can be used on several levels, even by the client.

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