Chapter 9
The Integration of 3D Survey Technologies for an Accurate Reality-Based Representation: From Data Acquisition to BIM Modeling

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ABSTRACT

The integration of close-range photogrammetry and terrestrial laser scanner enables reality-based modeling procedures that can help BIM modeling for existing buildings. The restitution of virtual models from high-resolution surveys is a complex process that requires much expertise. It incorporates concepts of resolution, accuracy, and precision in the acquisition phase; filtering, registration, and decimation for point cloud elaboration; and meshing, texturing, simplification, segmentation, and feature extraction in the final modeling stage. The previous steps are the same whether the ultimate goal is a classic 2D representation or a 3D one. For BIM modeling, the job becomes challenging because the necessary simplification of the model cannot be automatized and apparently collides with the high resolution and fidelity of original surveyed data. This chapter presents the process of surveying and 3D modeling of the Ghesc village, following the whole path from data acquisition to BIM modeling, discussing strengths and weakness, issues, and recent solutions for restoration interventions.

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INTRODUCTION

Today, 3D survey techniques, coupled with the integration of traditional survey, are the most in-depth tools of knowledge for both historical documentation and monument preservation. The first result of this process is expressed by graphic representation and technical drawing on which much of the subsequent restoration project depends; geometric accuracy and realistic texture of the 3D model become the principal tools to study Cultural Heritage and to understand how to protect it. Over the last 50 years, the evolution of reality-based 3D survey and modeling based on continuous technological and scientific developments in the field of laser scanners and photogrammetry has brought to light the peculiarity and richness of these tools and methods for an accurate form of knowledge and representation of the existent heritage.

The restitution of a 3D point cloud of the captured scene and the integration between different forms of analysis of the existing one formed the basis for the formulation of a representative system that integrates more skills to share the goal of knowing the existing heritage through its reverse model.

The point cloud, a fairly recent introduction in the survey of the existing architecture, now becomes the data input to create a BIM model, composed of objects with attributes that represent building components. We refer to attributes once included in a traditional survey with sketches and drawings but now possibly more detailed and digitalized. The BIM model starts from the semantic detection of objects created through a geometric modeling on previous information that has a certain level of accuracy.

The geometric definition of the elements is the first and sometimes the most difficult step leading to the definition of the HBIM (Historic Building Information Modeling) model; it faces the difficulty of providing a representation that a BIM-oriented software has not conceived for the detail and peculiarity of the built environment by its nature (Adami, Scala, & Spezzoni, 2017).

Also, building the geometry of an architecture, even if very accurate, offers only partial information; not considering anything of the materials or age of the building itself, not yet being a real reverse model of the built as the one from which it derives in terms of accuracy.

So the most important question is which kind of attributes should be included in the geometric model, or simply what is this model shaped and described for? All the elements can be defined for a specific purpose? from an historical study to a diagnostic one for a restoration project, and this influences its Level of Detail?

The description of the case studies in this paper helps to illustrate both a consolidated path from survey to point cloud and something still evolving in new directions, from point cloud to the BIM model, to reach the accuracy necessary for a Historic Building (Santagati, LoTurco, & D'Agostino, 2017a), giving us a working path and new research directions.

The aim of this paper is the description of the workflow used for a 3D survey and its processing applied towards future directions to a real case study. The object of the three-dimensional acquisitions is the small medieval settlement of Ghesc, located in the municipality of Montecrestese, north of the Val d'Ossola (Verbania). The village, made up of a group of nine stone buildings, has been abandoned for more than a hundred years, during which nature has often covered the ruins. The vegetation has included the growth of stone structures, creating a unique atmosphere and making the experience of survey more complex. In June 2007, when the first building was bought and restored (and is currently inhabited), "The Village Laboratory" was started, with the aim of transforming Ghesc into a vital space for the organization of school camps and study activities (Associazione Canova, n.d.). The site is a perfect case study, hosting active projects of restoration of the buildings in order to realize the purposes of the whole project.

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