From Vernacular to World Heritage

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ENHANCING VERNACULAR WORLD HERITAGE THROUGH DIGITAL TECHNOLOGY AND MULTIMEDIA TOOLS

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opposite page
Pienza, Italy
(© CHM Lab, DIDA, UNIFI, 2019)

During the past two decades, digital information and communication, accessible through mobile devices such as Laptops, Tablets and Smartphones, have taken on an increasingly central role in everyday life.
The interaction between ICT (*Information and Communications Technology*) and human and social sciences, embodied in the *Digital Humanities*, must also include the *Digital Cultural Heritage*, which has among its aims that of the valorisation and dissemination of the Cultural Heritage.
Disciplines that are distant in terms of focus of interest and research methods have doubtless taken advantage from the specific contribution that derives, in particular, from the use of info-graphics (Merlo, 2019), which has modified and enhanced the traditional approach to knowledge.

> Heritage… is our past history, the foundation of our future choices. To take out from the archives of the Superintendences and of the University those documents that contain the data of the research… – sometimes unpublished, often published in an incomplete form and almost never swiftly – making the information easily accessible to all, and not only to authorised personnel, means expanding the horizons of knowledge and therefore also of safeguarding and planning (Luciano Modica, 2013)

ICTs

Since the end of the 20th century, well into the digital era, alternative solutions, which make extensive use of ICT, have increasingly developed alongside the usual forms of usage and enjoyment of the Cultural Heritage. The communication/usage of the Cultural Heritage today uses, thanks to ICT, interactive, virtual reality and augmented reality applications, which allow, when used on the web, involving millions of users simultaneously. For this to take place, however, it is first necessary that the Cultural Assets be digitalised, and then made available through ad hoc hardware/software platforms (Merlo, 2019).

Digitalisation

Digitalisation is the process of conversion that transforms audio, video, images, texts and 3D objects from analogic to digital, thus making, in other words, a virtual copy of a real artefact that is as faithful as possible to the original.
It is thus, a first important distinction regarding the nature of the object to be digitalised and the output that one wishes to obtain. In the case of 3D artefacts, in fact, present day technologies permit the creation of a digital copy in the form of a 3D model using acquired dense point clouds.

3D laser scanner
An instrument used for recording a digital point cloud from the reality
(© *CHM Lab, DIDA, UNIFI, 2019*)

In the field of real estate assets, this process (also known as digital survey) is carried out with the use of active and/or passive sensors (the former trough the use of Lidar tools, and the latter with the use of photogrammetry techniques), which allow the realisation of reality based 3D models, initially point cloud and subsequently polygonal (with or without colour textures), of the actual structures (Russo et al., 2011). Neither of these two methods is invasive, and both take place without direct contact with the object, through the mediation of optical instruments that render the surfaces of the structures as 3D models, placed within a virtual Cartesian space.

The main difference between the two methods consists in the fact that the active sensors permit obtaining range based point cloud 3D models already during the data acquisition phase, whereas the passive sensors, in order to obtain the same results, require mathematical algorithms for transforming homologous pairs of points present in the two-dimensional photographic images into 3D coordinates (SfM technique – *Structure from Motion*).

Furthermore, the point cloud derived from a laser scanner survey is in itself a model at a 1:1 scale, whereas in the photogrammetry survey the point cloud and the subsequent mesh model need to be put to scale by using at least a known measure.

Generally, where a greater detail is necessary, a combination of modelling techniques is used, which preserves the dimensional and geometric features of the structure (reverse engineering); whereas when it is possible to render the forms of the architecture through elementary surfaces, direct modelling techniques (*box modelling*) are preferred.

The copy (or *facsimile*) of the real object, as faithful to it as possible in morphometric and perceptive, replaces the object itself in the digital (virtual) environment, opening, in fact, the possibility not only of interacting with it, but also of analysing, studying and promoting it through forms and tools that were

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Trasformation of an artefact into a 3D model
(© CHM Lab, DIDA, UNIFI, 2019)

inconceivable only a few decades ago. Among the many possible applications it is worth mentioning digital conservation, digital restoration, VR/AR applications, archiving, cataloguing and finally, geographic systems (Ruggeri, 2019).

The realisation of a polygonal model of an existing building is not an automatic or mechanical operation, but rather the result of cognitive analyses and critical choices (Merlo, 2019). Independently of the purposes for which it must be produced, preliminary studies aimed at understanding the building from the morphometric, historical and material points of view is essential, recognising the various elements that compose it (semantic analysis), ordering them hierarchically in function of their role, the materials with which they were built, the rules that subtend their form (taxonomical analysis), and ascertaining the spatial relationships that they establish between them (topological analysis), so as to determine the overall volumetric articulation (Gaiani et al., 2010).

The work pipeline is greatly transformed when the polygonal model no longer needs to represent an architecture in its currently visible 'facies', but in one of the moments that have preceded it considering the spatial measurements established by the material and intangible history of the building. In this case the analysis of the morphometric data, *tout court*, of the parts that have been preserved as they were, must be necessarily completed (on occasion substituted) with the interpretation of the historical-documentary data taken from iconographic sources and/or more frequently from literary sources. In these cases, the reconstructions are based on conjecture (Avella, 2018), and will be more or less valuable depending of whether they are based on certain suppositions or credible hypotheses.

In this specific field, although in fact the modelling operations are aimed at obtaining 3D reconstructions of the forms of a building, even if it does not exist anymore, it no longer makes sense to speak of reverse modelling, due to the limited nature of the geometric data available, and to the manner in which

it was acquired. Consequently, the resulting *maquettes* will be produced essentially with the use of direct modelling techniques, capable of ensuring a compromise between the simplification of the forms and verisimilitude (Carlevaris, 2011).

3D rendering: static rendering, animations and walkthrough

In function of the level of detail sought and consequently to be viewed through static or dynamic rendering, either photorealistic or lacking in texture, and based upon the modelling techniques used, the *maquette* may be more or less detailed. In any case the realisation of a 3D model assumes that the author has the necessary competencies for de-codifying and re-codifying an architecture, without which it would be unthinkable to achieve a correct representation of the building.

In those cases, where the models are to be used for animated sequences, and specially when they will be utilised for real-time viewing, for example in walkthrough platforms (virtual walks), techniques derived from the entertainment industry are adopted. These allow, through baking procedures and the use of UV maps (such as normal maps and diffuse colour maps), to represent the geometries of the most minute elements of mesh models, made of few polygons with a high degree of realism (Merlo et al., 2013).

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Image of a high-poly, low-poly and low-poly model + texture
(© *CHM Lab, DIDA, UNIFI, 2019*)

Example of a spherical panorama
(© *CHM Lab, DIDA, UNIFI, 2019*)

Spherical panoramas and 360° videos

Panoramic photography is the technique that permits creating an image with a field of view in a range between 180 and 360 degrees through a composition (mosaic) of adjacent photograms. Panoramas can reach 360 degrees horizontally (cylindrical panoramas) and 180 vertically (spherical panoramas). In this case, therefore, no 3D models are used to simulate an environment, but only two-dimensional images.

Panoramas can be immersive and interactive; the user can move within a scene and interact with the objects that are a part of it. However, unlike the previous techniques, it is not possible to obtain metric data from them.

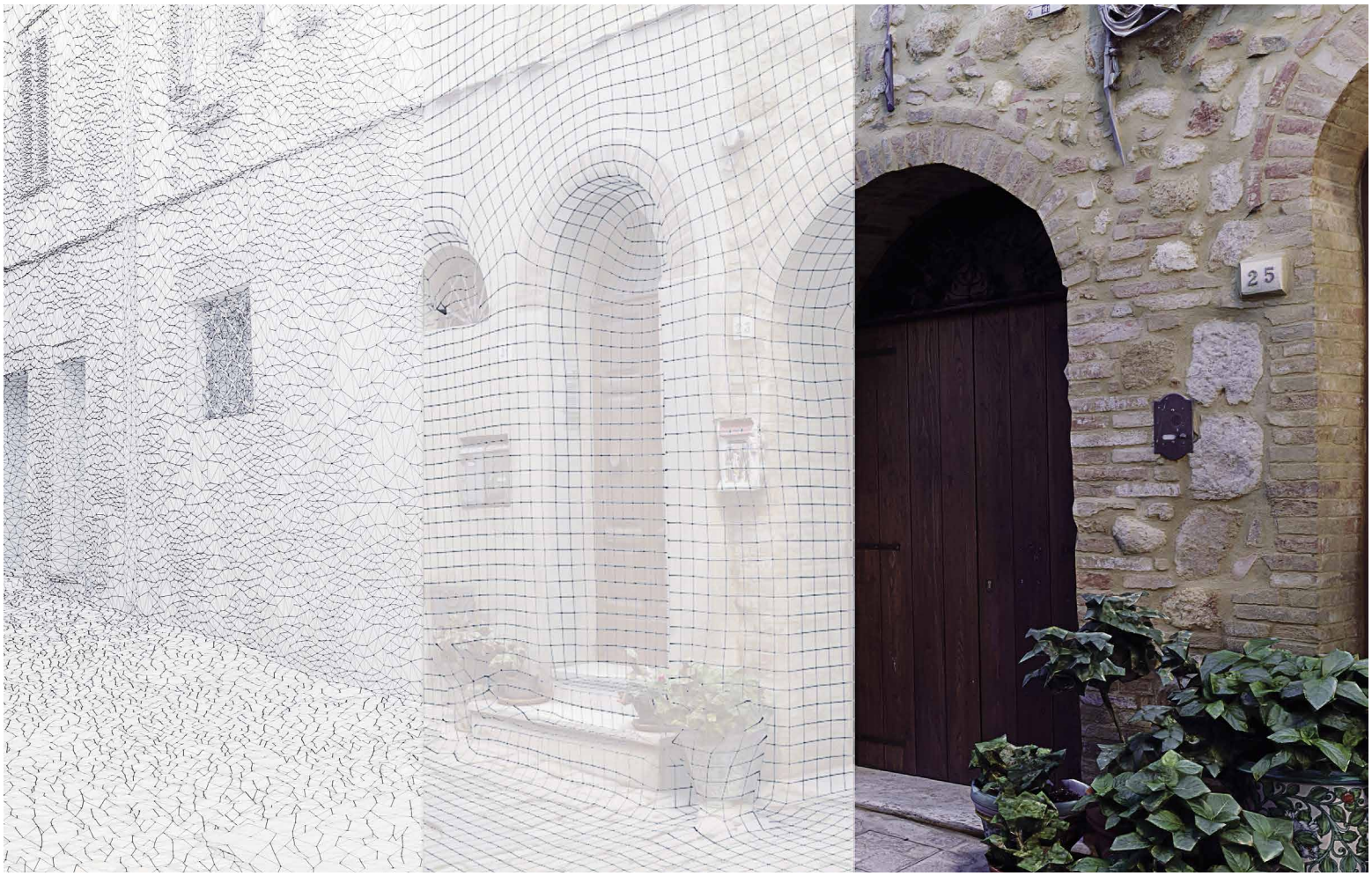
A 360 degree video consists instead, of a sequence of spherical images. Although the movement of the camera has been previously determined, the user has the possibility to choose where to direct his gaze, while the scene evolves around him.

Virtual Reality – Augmented Reality – Immersive Reality

Virtual Reality (VR) can be defined as a digital copy of the world that surrounds us, carried out through digital tools and techniques.

Immersive Virtual Reality (Immersive VR) is the possibility to explore and interact with virtual reality using devices (headset, gloves, earphones) that project the user into a digital environment.

Augmented Reality (AR) can be defined as an altered representation of reality, in which additional information is added to the normal perception acquired through the five senses.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A single term, Extended Reality (XR) (Chuah, 2019) is increasingly used to define these environments as a whole. In the specific field of Heritage, XR is often used for the 'typological' or 'philological' reconstruction of an asset. This difference, which is linked to the quantity and quality of the written and iconographic documentation available, although generating similar products aimed at the reconstruction of the image lost with the passage of time, is considered by scholars as a discriminating element, which should be highlighted during the model conception phase (Cochetti et al., 2018).

Today, it is the entertainment industry that finances this sector, mostly directed to the young and very young, who are those more interested in alternative systems for using and enjoying heritage. Video-games, a mass tool for experimenting with man-machine interaction techniques, when used for educational purposes (serious games), can be profitably utilised in the field of *edutainment*, which is aimed at acquiring content through play. Also the sector of Cultural Assets has experimented, often successfully, with this technique. An example of this are the many products developed by national and international universities and research centres (Gabellone, 2020).

The London Charter (2009) and the Seville Principles (2011)

The main references in the field of the valorisation of the Cultural Heritage through digital tools and methods are the *London Charter* (http://www.londoncharter.org) and the *Seville Principles* (http://smartheritage.com). The former concerns the convenience, or not, of using 3D viewing in function of the objectives to be achieved, also touching upon the methods and tools to be used (Gabellone, 2012). The latter proposes specific guidelines for the various fields in which it operates, with special reference to that of Virtual Archaeology (Brusaporci, Trizio, 2013).

The digitalisation of heritage is at the centre of the cultural policies of European countries as shown, for example, by the MiBAC initiatives in Italy (Direzione Generale Educazione e Ricerca, 2018; Direzione generale Musei 2019).

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