Architectural Library. Dioscuri Temple in Agrigento

Laura Inzerillo
DARCH Palermo University
Viale delle Scienze ed. 8
90100, Palermo, Italy
laura.inzerillo@unipa.it

Giuseppe Dalli Cardillo
PhD Palermo University
Viale delle Scienze ed. 8
90100, Palermo, Italy
dacar@libero.it

ABSTRACT

This paper presents the synthesis of research about the ICT solution for cultural heritage through the innovative technology of representation and survey. One objective was to identify a method of processing data for knowledge, dissemination and preservation of the asset. Historical analysis, surveying, photogrammetry and laser scanner, the processing of survey data and modelling are all focused to the same final purpose. The methodology developed for this application framework becomes adoptable in General for Cultural Property, which become in turn the protagonists of 3D WebGIS.

Keywords

Architecture, 3D web, Geometry, 3D modelling, Dissemination, Communication, AR.

1. INTRODUCTION

In recent years, the problem of communication for the conservation of cultural heritage has been tackled.

The literature today requires the use of the web as a primary tool for the *dissemination*, *communication*, storage and knowledge on architectural buildings.

Through the case study examined, the Temple of *Castor* and *Pollux* in the Valley of the Temples in Agrigento, the *technological know-how* of communication, required to have the adeguate cultural diffusion of a building of architectural or archaeological value, has been determined in terms of *accessibility*, *queryability*, *manageability* and *interactivity*. 3D modeling is an essential element in the understanding, enjoyment, and historical analysis of both architectural and archaeological cultural heritage. The creation of a 3D model involves applying a methodology that, inevitably, assumes that the operator that makes the model is a masters in history, geometry, in metric, compositional, architectural, archaeological, and semantics of the cultural architectural heritage. However, it is not generally the case that the operator coincides with the researcher or with whomever has the critical skills for the realization of a functional and usable model. The steps leading to the creation of a 3D model are well known to researchers in the field of representation, and are easily understood even for non-experts. In fact, the operator must know the cultural architectonic heritage both historically and then metrically, to be able to represent it. To understand well and know a cultural heritage metrically it is necessary to apply survey technologies such as the topographic method, the normal or stereo photogrammetric method for texture mapping or laser scanner for point clouds. Mastery of the technology allows the user to create effective items within a reasonable time. Skills in the field of survey must be accompanied, unavoidably, by an upgrade of the data collected. Once the model is developed, geometrically correct, metrically accurate, and aesthetically perfect, one wonders what the main aim is; what purpose does this small object serve? It is difficult to manage due to its size in terms of bytes, and it is so beautiful that you are almost afraid to manage it. So we have arrived at the focal point of the matter: the purpose. Yes, we could talk about goals aimed at historical knowledge of cultural property; or goals aimed at the disclosure of architectural geometry; or, again, of the strata, of anastylosis, of typological-semantic compositions, of structural conditions, of wall cladding, of artistic value, of restoration... Thus the model is made to answer one or more of such questions, and the user would be the recipient and unique depositary of the asset. But this cannot and must not satisfy the thirst for knowledge, and especially it must not silence the conscience that now, more than ever, needs to provide a future for future generations, the same vision that for us has been a source of cultural, ethical, aesthetic, poetic and ascetic inspiration. It means that, with a view to sustainable development,

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cultural heritage is not an element that is separate from the context, is not an end in itself, but belongs to a network of connections, a woven fabric of relationships, an economic system. This cultural heritage belongs to the community, but only for a limited and short-sighted period until the asset loses some of its value and is relegated to the few fans who still find it a value. Architectural heritage belongs to the historical memory of each of us and, at the same time, the future memory of those who can still enjoy it and make it part of an accomplished life. We must, therefore, enhance architectural heritage through extended and wide-spread dissemination that is for everyone, experts and non-experts. Architectural heritage must enter people's homes to be appreciated by presenting graphical models that are *easy* to *manage*, *easy* to *use*; where a click is the link that satisfies our thirst for *practical information* (on opening times, cost of tickets, guided tours, group discounts, etc.), *generic information* (history, iconography, structural layers and/or anastylosis through real-time animation, virtual tours within the structure, immersive paths in *AR*, typological architecture or archaeology, marble coverings, paintings, authors, etc.), or *specialized information* (geometric sections that fetch moving plans with a choice of static characteristics, examination of the foundations, monitoring the state of conservation of the property, mapping of the restoration, calculation of surfaces, etc.).

PILOT PROJECT

We identify a pilot project that became the point of departure with the past, in order to maintain and preserve the cultural heritage for future generations.
When we talk about the pilot project, of course we must consider an important transaction that involves the whole relevant scientific community, both nationally and internationally. We refer to the substantial problem of making the data consistent, *accessible*, *interpretable*, *usable*, and *processable* from all points of view and in all scientific fields. The homogeneity affects all sectors, not only thematic areas such as history, restoration, geometry, etc., but the *homogeneity* of *navigational queries*. In essence, it is the realization of a *framework* that involves itself in every aspect of the development of a model, a method. When constructing a pilot project we have to take account of *benchmarks* that overall make the product *universal* and *accessible*. Some of these parameters are easy to understand, for example think of a timeline or ranking. It is clear that a homogeneous product has a similar load time: it is unthinkable that there may be a very long load time to download sizeable models that are difficult to manage. It is also true that in a project that is intended as a global product, there is a set of webpages that follow similar philological paths according to a typological classification for the ease of identification. The purpose of the project should be recalled: it is necessary to return to the *diffusion* of the *knowledge* of the *cultural architectonical heritage* through its facilitated and simplified disclosure to the point that the cultural heritage itself becomes part of the everyday. This creates the preconditions to understanding the cultural heritage, the story of its past, and also of his future through conservation planning and effective communication.
Let us look more closely at the methodology required, starting from the architecture's history and ending with the creation of 3D WebGIS.
All material on all pages should fit within a rectangle of 16 x 23.7 cm (6.3"x 9.33"), centered on the page horizontally, beginning 2.5 cm (1") from the top of the page and ending with 3,5 cm (1.4") from the bottom. The right and left margins should be 2.5 cm (1"). The text should be in two 7.6 cm (3") columns with a 0.8 cm (0.3") gutter.

2. THE SURVEY

Historical and iconographic analysis

Agrigento was founded on a plateau overlooking the sea, with two nearby rivers, the Hypsas and the Akragas, and a ridge to the north offering a degree of natural fortification. Its establishment took place around 582–580 BC, and it is attributed to Greek colonists from Gela, who named it Akragas. Akragas grew rapidly, becoming one of the richest and most famous of the Greek colonies of Magna Graecia.

Topographic survey

Detecting architecture means rebuilding the concept of its designer, his technical construction choices and his realization strategies. The "measure" has fundamental value; technological advancement helps us achieve greater accuracy and speed. However, the measure must be supported by a pre-critical understanding of the cultural heritage; this knowledge can alone ensure the significance of the survey itself, a definition of high effectiveness and completeness that deserves careful analysis in order to understand the full meaning of its content. The survey is a set of operations of knowledge that contribute to the reconstruction of the life, history and lifecycle of an architectural building.
The procedure adopted, by applying the so called polygon technique, has allowed us to identify an appropriate number of consecutive fixed points (so that each point is visible from the following and the antecedent), therefore constituting the vertex of a closed broken whereby sides and corners are measured.

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The photogrammetry and the photomodellation of built heritage

New technologies offer the ability to create and share knowledge. The digitization of heritage contributes to the development of the information world.
The current tools and techniques of relief and representation give access to results to date unimaginable about precision, speed, comprehensiveness and realism. We know the potential that photogrammetry offers to the survey. Today, photomodellation makes it possible to operate in a work space allowing the 3D restitution of the built heritage, based on the global integration between the phases of surveying, modeling and representation. Apply photomodellation to the 3D reconstruction of buildings implies that an operator must to employ an interpretative effort that involves an understanding of the architectural forms that make up the building.

Laser scanning and cloud points

Laser scanning of the temple of Castor and Pollux has produced a highly-detailed point cloud. The large number of information derivable from it is, however, proportional to its difficulty of management. In fact the high amount of data is both the point of force that criticality of the detection mode with laser scanner.
It was necessary to maintain a good approximation and precision with respect to the detected object without affecting the objective of research, i.e. to obtain a manageable model that is also interrogable in real-time. A often adopted solution is to decimate the point cloud, however in our case this was not advisable. In fact, the temple was built of sandstone, and if we had used the method mentioned we would have risked losing some important information.

3. OUTPUT FOR KNOWLEDGE

Post processing and testing

To overcome the difficulty of management we decided to use the technique of Retopology, well known in the cinema sector: which consists of a system that generates new polygons, a new mesh that adapts itself to the existing one which is the basis and the reference. The new polygons, which are generated manually with total control by the opera-tor, follow a new "topology", that is orderly, precise, and usually supported by a lower number of triangles: it is optimized according to the areas to "trace".
The creation of a mesh derived from a point cloud is often the result of complex and disordered triangulations. Retopology solves this problem through the reconfiguration of the geometric shapes that make up the cultural heritage through a rational division into triangles or quadrangles. In fact, the automatic algorithms are often designed in a way that even a very simple surface or plane surface will be described by an exorbitant number of polygons or triangles, making the portion in question unnecessarily rich in information while the same could be well described by a lower number of polygons without loss of quality.

Geometrical and 3D model

Such models are precise but also easy to manage, and allows a model to be developed for immersive and interactive visualisation systems, such as rendering and real-time augmented reality. These solutions have led to significant results, in both the scientific and disclosure aspects of the product, such as the ability to make the model of the temple "appear" superimposed on the real one, and allowing switching from one model to another at the touch of a button. Furthermore, you can also "walk" inside the building; and an experimental trial also included the possibility to make so-called *hotspots* appear – accessible via the mouse to some specific points of the model – providing additional retractable information, pop-ups, for example text analyses or pictures or video explanations. Now that we have a model corresponding to the requirements, some important elements to be added are *textured shaders* to improve the *real-time* visualisation of the cultural heritage.
In the field of optics, *shaders* are commonly used to simulate the diffusion, reflection, refraction and dispersion of light. The latest *Graphics Processing Units* has *papelines* used for transformation of a 3D scene in a raster image that can be represented on the screen. The *pipelines* carry out the operations based on programmable *shaders*.

3Dmodel for Google Earth

The model that is implemented in Google Earth is generally a model that responds to the generic requirements of modelling, including non-photorealistic aspects. A feature of the model is georeferencing, which responds to a link that refers to photographs and other links that lead to sites related to the cultural heritage. Each part was modelled correctly under the metric and geometric profile and trying to reconcile the complexity of the model with the limitations imposed by GE, for example the number of polygons of each three-dimensional element. The mathematical model is transformed into a numerical model. As the model further progresses, is also ensured that objects are represented in translucence, for example to highlight horizontal or vertical sections of the building’s facades or of the model in anastylosis. The rendering and the creation of texture useful for interactive exploration were undertaken using Cinema 4D with Ambient

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Occlusion. The georeferencing of the model and of each point on of the model's sides allows the querying of any part of the model with a click of the mouse. This work was developed in Andrea Palladio 3D Geodatabase, a geo-database of a three-dimensional web-based platform where 3D models integrate a large *Palladian Informative System*.

3D GisWeb

The study of a 3DGisWeb requires good knowledge and expertise to identify the appropriate communication channels in order to achieve the initial goals. Among the new generation of software you could include Geoweb3D, which combines the potential of the Web with the dell'ArcGisTabs and 3D. Progress in geospatial visualisation and analysis is all about making it easy to use, making it work with all available formats and maximising the effective communication of user data. The User Interface is extremely intuitive and is what app users now expect. Users do not need to know anything about 3D modelling. Load your data, style the appearance, save it and share it – that's it. Constructing those apps with endless small buttons, complex dialogues, and high learning curves is the opposite of what the user wants. Users no longer need to convert or restructure their data in any form. As the data changes, so will the visualisation. Most *raster*, *vector*, *kml*, *web services*, and *3D model* formats are supported. *ESRI* users can load *MXDs*, use their geodatabase and access *ArcGIS Server* content. Data is reprojected on the fly from any of the thousands of supported coordinate systems. *Geoweb3D* has been built from the ground up by leveraging the latest in video card *GPU technology* and developed exclusively for geospatial 3D visualisation and analysis; it is not a repurposed application nor CPU-reliant architecture developed before gaming technology was mainstream. This is the best of GIS and the best of 3D. Users need the seamless integration of the disparate GIS formats, feeds, containers and delivery mechanisms that vary among users, organisations and agencies. Geoweb3D, although supportive of standards and modern software design, will scale with the industry. Those users confident that a currently common format will not be replaced are those ones trying to find the DVD drive on a tablet.

The only constant in this industry is change.

4. CONCLUSIONS

The method applied, and outlined here, shows that the adopted system leads to space-time web collocation of the architectural heritage. The product is easy to access, enjoy, interact with, manage, monitor, thus ensuring disclosure and therefore safeguarding knowledge and conservation.

This means that the potential of the architectural heritage is valued to the extent that it is possible to fulfil the requirement of sustainability declared by the Bruntland Commission: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

The architectural heritage belongs to a network of social, economic, architectural, archaeological, touristic and cultural movements. All these aspects are needed for the conservation of architectural heritage.

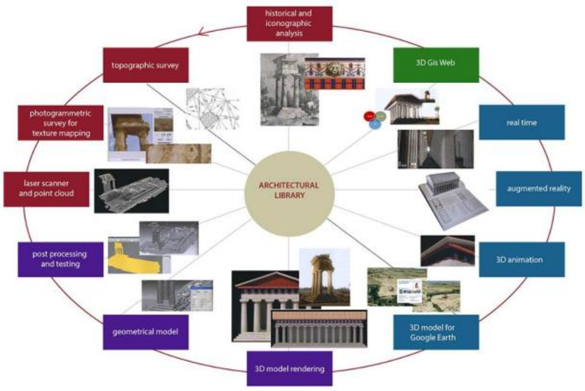

Figure 1. Know how: from history to the 3D WebGis.

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