



REPORT ON THE DIGITAL RECONSTRUCTION OF THE 4TH CENTURY SUSA (WORK IN PROGRESS)

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Abstract:

The reconstructive study of the urban arrangement of Susa in the fourth century arise from the intention to exploit some resources derived by local studies and survey activities fulfilled by innovative methods from which the modeling of architectural heritage (AH) and virtual reconstructions are derived. The digital Segusio presented in this paper is the result of intensive discussion and exchange of data and information shared among the urban landscape documentation activities, and systems of virtual models generation, able to provide the charm of an ancient landscape. The land survey has been accomplished using aerial and terrestrial acquisition systems, mainly using digital photogrammetry from UAV (Unmanned Aerial Vehicle) and terrestrial laser scanning. Results of both methods have been integrated to medium scale geographical data available from regional map repository and some processing and visualization supported by GIS (Geographical Information System) have been fulfilled.

Then, starting from accurate and detailed DEM (digital elevation model) and from other architectural scale models concerning the ancient heritage, the modelling of the ancient scenery arose. The reconstruction of an ancient scene begins with an accurate account of all the evidences from the studies of materials and documentary sources. The analysis and representation of the territory, supervised with the tools of geographic data management, are therefore primarily a media of analysis, then of comparison and validation with other data. Only after these steps, the land and the built heritage models become tools of communication and education, which are the typical functions of the virtual reconstruction of ancient environments. The integration of the history of city with digital and multimedia resources will be offered to the public in the city museum housed in the restored castle of Maria Adelaide, which stands in the place where the acropolis of the city lay in ancient times

Key words: digital archaeology, 3D models, 3D survey, GIS, cultural landscape, 3D reconstruction

1. Aims

The history of the valley and the city of Susa in the Celtic and Roman periods are widely present in the literature, especially related to archaeological investigations, which is a scientific proof of the interest of the land's history and its heritage.

The ancient remains are partly well-preserved but a unified and organic transposition of this important story told through modern multimedia has not yet made. Such tools are currently recognized to be a feasible means to bring the stories of the past to a wider audience, even, and perhaps in specifically, that in school age.

The innovative tools and the significant advances that have radically changed and expanded the descriptive potential of traditional metric survey techniques are now more adaptable to the evolving framework of needs,

featured by a rapid specialization in many fields of application.

Especially when the relationships with the natural environment and the landscape are significant (but now the belief that it is a relevant factor in any context is shared), it has to be possible to relate the objects of historical and archaeological interest with the natural component of the landscape.

This paper reports the development of a study that started from the set of known information about the city of Susa and continued with the adoption of innovative survey systems, terrestrial laser scanning and aerial and terrestrial photogrammetry, for the documentation of archaeological preserved emergencies in relation to urban and natural territory. The spatial multiscale information managed with GIS tools in a single system has enabled to achieve in different phases of approach

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to the ancient hypothetical configuration, until the 3D virtual reconstruction.

2. Brief news item on the history of the city

Segusio (today: Susa, near Turin, Italy) is located at the far west edge of the Po Valley, where the climb towards the passes of Mont Cenis and the Montgenevre start. The present paper concerns this city of Celtic origin.

We know nothing concrete on Celtic Segusio, however we know perfectly the time when Segusio entered in the influence of Rome.

The Arch of Augustus is the imposing and very well preserved monument describing this particular moment. The arch arose in the year 8 B.C., as a testimony of the agreement arranged between the Celtic king named Cozio and Emperor Augustus. (Fig. 1)



Figure 1: Integrated photogrammetrical and laser scanning model of the Arch of Augustus.

Unfortunately, the related ruins are very limited, but a typical Roman urban arrangement, with temples and monuments and without town walls may be assumed. (Mercando 1993; Barelo 2007, 2008).

In an imprecise moment but dated somewhere around 275 AD, the "first Susa" was violently swept away by one of the first barbarian invasions. Therefore, a "second Segusio" developed presumably in about ten years, not as an open city but as a heavily fortified urban settlement (Dezzani and Patria 2009, 2010).

That Segusio has been submit to a digital reconstruction. More precisely, the attempt is the reviving of Segusio in 355 AD. Marcellinus was traveling with the emperor, and he left a description of Segusio defining it as a fortified city.

3. Landscape and Heritage reality based modelling

The new survey technologies offered by Geomatics allow in a rather accessible way to acquire terrestrial and aerial data compatible with each other, so the integration is possible. The low altitude of UAV flights is particularly

significant in the field of ancient and architectural heritage located in urban contexts. This ability added to the chance of describing an object from different points of view, aerial and terrestrial ones, are a topical issue in the architectural and landscape survey and modelling since this operation makes possible to analyze the objects in a more detailed and complete way, helping the phase of knowledge, comparing and monitoring.

The ancient Architectural Heritage (AH) of Susa has undergone in the recent past to a wide campaign of surveys, via terrestrial techniques (photogrammetry and laser scanning) and aerial methods by the use of UAV photogrammetry, with the aim of documenting and thus enhancing a little-known heritage (Aicardi *et al.* 2015).

From UAV photogrammetry images it is possible to extract point clouds, 3D textured models, Digital Surface Model (DSM) and Orthophoto. The data processing techniques are mainly automated by an image matching approach (Kersten and Lindstaedt 2012; Remondino *et al.* 2014) The automation derive from the use of the Structure-from-Motion (SfM) method, that allow estimating the 3D position of points represented in multiple images, reconstructing the geometry of the represented object (structure) and the acquisitions position (motion), even when are not available the defined camera calibration parameters.

Moreover the LiDAR technology (Light Detection And Ranging) is well-established for applications in the field of Cultural Heritage, in the knowledge and documentation phases, allowing to gain a lot of information on surfaces also articulated with a high precision and quality.

The obtained 3D models are featured by the different resolution and a multiscale information content. (Fig. 2).

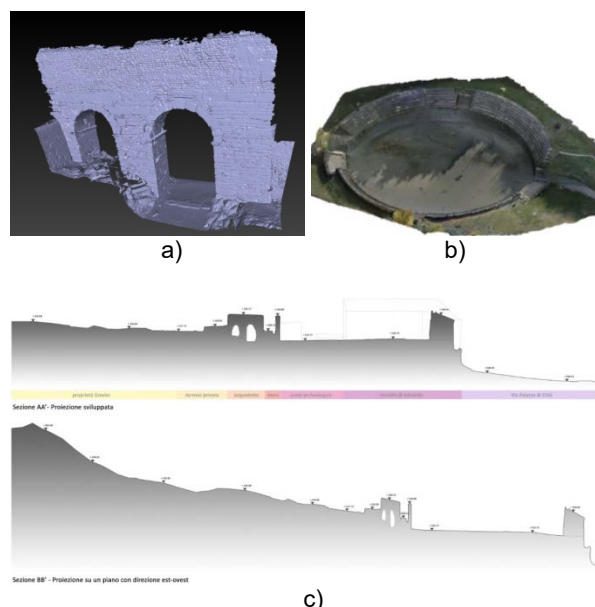


Figure 2: 3D models: a) Very high detailed model of arches of the aqueduct; b) UAV model (30m height flight) of the amphitheater; c) Section profiles, accomplished by GIS tools, aimed to study the path of water flow connected with the aqueduct arches.

This is the reason why the data at different scales have been finally implemented within a GIS structure in order to connect multiple needs.

4. The ancient city model

One of the most critical aspects in the study of reconstruction of monuments and ancient cities is the need to assume shape and consistency of public and private buildings especially in their configuration in elevation, and compositional aspects of fronts.

Despite the objective lack of direct material sources, inevitable in the contexts in which the urban continuity has succeeded over the centuries up to the present configuration, the graphic reconstruction was inspired by the representations and descriptions handed down by historical figures who saw directly the chosen scene (as Ammianus) and of course the available literature of studies, research, insights.

Given the scarceness of data assured, the accomplished virtual reconstruction, does not claim to be a true representation of a bygone era, but rather wants to be credible in the general overview and in some of its structural parts.

We therefore believe that the reconstruction model created (Fig. 3) show a credible idea of how the city could appear in 355 A.D.

It was a small town of about 1,500/2,000 inhabitants, including the *Cardo* and *Decumanus* as main streets, but with an additional artery that connected the two major ports: Port Savoy and Porta Piemonte.

The city then had a regular frame, but not squared with the *Castrum* area and the Arch of Augustus that dominates from the imposing fortress. A back door also allowed the exit to the arena, located outside the walls in a natural depression. The city wall was surrounded on the north by the river Dora, to the east by the river Cenischia and to the south by the ditch.

We believe that this project will lead to demonstrate the valuable possibility of using heterogeneous tools of investigation, analysis and representation of the territory and of the built heritage developed within different scientific communities, enabling to group the study outcomes into products that communicate ancient scenarios in some detail.

The use of the results of historical research, as well as those of the non-standard photogrammetric surveys (UAV) and terrestrial laser scanning (TLS), the management of geographic information in GIS and even virtual reconstruction tools (Maya – Autodesk) have made possible to coordinate the pieces of certain knowledge and and those hypothesized in a single "picture" of the whole city.



Figure 3: The reconstructive model of Segusio.

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