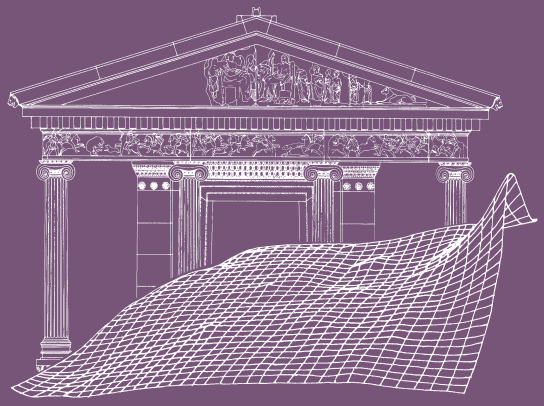

# KNOWLEDGE, ANALYSIS AND INNOVATIVE METHODS FOR THE STUDY AND THE DISSEMINATION OF ANCIENT URBAN AREAS

KAINUA 2017

Proceedings of the KAINUA 2017 International Conference in Honour of Professor Giuseppe Sassatelli's 70th Birthday (Bologna, 18-21 April 2017)

edited by
Simone Garagnani, Andrea Gaucci

ARCHEOLOGIA E CALCOLATORI
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*All'Insegna del Giglio*

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# THE *NORA VIRTUAL TOUR*: AN IMMERSIVE VISIT IN THE ANCIENT CITY

The ancient city of Nora rises up on the southern coast of the island of Sardinia (Italy) and it was established on a large peninsula that marks the Gulf of Cagliari at its southernmost point. The early Phoenician phases of the settlement date back to the mid-8th century BC (Bonetto 2013), but its development as an urban centre took place throughout the Punic and Roman Republic periods (late 6th-2nd century BC: Bonetto 2016; Bonetto in press). The town acquired the *ius romanum* as municipium in the Augustan Age (1st century BC-1st century AD: Bonetto 2002), but the *climax* of the monumental development of Nora is clearly attributed to the Severian Age (195-235 AD: Bejor 1994; Ghiotto 2004, 183-186; Fabiani 2013).

Nora was extensively excavated by G. Pesce in the 20th century, between the 50s and the 60s (Pesce 1972), but in the last 25 years an inter-University group (University of Padova, Genova, Milano, Cagliari, Viterbo, Pisa, Venezia) has carried out investigations all over the archaeological site. The University of Padova has focused its researches on the eastern part of the city, first in the Roman forum and in the underlying Punic neighbourhood (Bonetto *et al*. 2009b), then in the area of the so-called Roman Temple (Zara 2015). In recent years, the archaeological analysis has been extended to a private building close to the forum (Ghiotto *et al*. 2017), as well as in the so-called *Eshmun*/ Asclepius Sanctuary (Bonetto, Marinello 2017) and in the Phoenician and Punic necropolis (Bonetto *et al*. 2017).

The archaeological park of Nora attracts more than 60,000 tourists every year, hence the University of Padova has always endeavoured to restore the monuments at the end of the excavations (Bonetto *et al*. 2009a; Berto, Zara 2016), by using non-invasive methods (e.g. gravels with different colours, useful to recognize the different functions of coated surfaces, wooden and mudbrick structures to rebuild ancient volumes and so on). In spite of this, serious difficulties are experienced by visitors in understanding a landscape of ruins with barely visible evidence: the meaning of ancient structures arranged in a complex palimpsest is confusing and hard to understand for specialists and almost impossible to imagine by tourists.

Thus, in order to properly disseminate the knowledge acquired and to generate a public awareness of importance of researches results, a complete virtual reconstruction of the ancient city has become a primary need. 3D models of the Phoenician settlement and the Middle Imperial Roman city have been developed (Fig. 1), by combining the archaeological knowledge of scholars involved in the research project with the technical knowhow of a digital company specialized

Fig. 1 – Aerial view of Nora peninsula nowadays (photo: G. Alvito – Teravista) and in the Roman Middle Imperial reconstruction (graphics processing: Università di Padova, Ikon).

in interactive solutions (Ikon, Staranzano – GO). First of all, a complete Digital Terrain Model (DTM) of the ancient landscape has been realized (terrestrial elevation and bathymetry analysis), with a particular focus for the shoreline evolution (Bonetto *et al.* 2015) and for the relevant vegetation elements (e.g. Mediterranean maquis). The solid modelling of the monuments (Reilly 1991) has been based on the archaeological plans produced by the Universities in the last 25 years of diggings in Nora: each plan has been digitized (Nemetschek Vectorworks), reshaped and simplified (e.g. complex polylines converted into straight lines; partial plans completed in the most likely way), in order to produce this way an optimised 3D extrusion of the whole ancient city (Autodesk 3D Studio Max) and to allow a direct reading of Phoenician and Roman reality that 2D representation cannot represent (Tufte 1990).

J.B.

In a second operational phase, the five main monuments of the Roman city (forum, theatre, Roman Temple, *domus* of the Atrio Tetrastilo, baths "a Mare") and four urban crossroads have been rendered in greater details (Fig. 2).

Fig. 2 – The Roman forum of Nora nowadays, after the restoration (photo: G. Alvito – Teravista) and in the Roman Middle Imperial reconstruction (graphics processing: Università di Padova, Ikon).

Sample-based textures have been generated due to a complete analysis of the quarries in the inland of the ancient city (Previato 2016) and an accurate analytical study of the ancient building materials employed in Nora (e.g. andesite and sandstone blocks, mudbricks, marble slabs, wooden beams): thanks to such a complete study of ancient building materials, the reconstruction has gained a photorealistic effect comparable to the real landscape of Nora. That provides a gateway to the users to enrich and decode the real world thanks to the artificial world of the virtual (Rheingold 1993). The models have also been implemented with furniture and decorations that are preserved in Nora and that have been selected analysing reliable source of information (e.g. rooftops and painted walls in the *domus*, sacred objects in the temple, stalls and goods in the forum). In order to improve the illumination of the scenes and to enhance the realism, light objects (e.g. candlesticks, braziers, sunlight through the windows) have been placed in keypoints.

Once the 3D models have been completed, 17 HD equirectangular renders have been exported (.png 6,000×3,000 pixel, 72 dpi), in order to realize an immersive visit simply loading them through a browser on pc, tablet or

smartphone. To ensure the effect "as it was, as it is", 4 HD equirectangular projection panoramas of the Nora peninsula (.jpg 10,000×5,000 pixel, 96 dpi) have been taken from a helicopter (Teravista, Cagliari); these images allow the user to better locate the archaeological site and, at the same time, to compare the 3D model of ancient landscape with current remains (Hermon 2007, 143) and to give a personal and critical evaluation of the reconstruction. The guided itinerary through the archaeological park has led the selection of the renders and photos points of view, with the aim of generating an immersive and interactive approach in interpreting ancient remains and of building a user-friendly "virtual heritage" (Gabellone 2015, 223-226), allowing alternative readings of ancient reality (Diodato 2005). In short, the project aims at proposing a virtual reality tour, computer-generated, three-dimensional and interactive (Heim 1993, 109-128; Lévy 1996), yet accessible on site, in open area, as a "virtual environment", composed by three-dimensional models that can be navigated and that users can exploit as a "microscope for the mind" during their visits (Hermon, Fabian 2002; Gabellone *et al.* 2014).

Finally, stereoscopic images of 3D reconstructions and aerial photographs have been uploaded in the *Nora Virtual Tour* App, a purpose-built Android application for mobile headsets that provides immersive virtual reality for visitors, that can enjoy the interactive experience on site, in a guided tour through the archaeological park (Fig. 3). The app is designed in two versions: an app for tablet (Samsung Tab A) and an app for mobile virtual reality headset (Samsung Gear VR), powered by a smartphone (Samsung Galaxy S6) that acts as the headset's display and processor (Oculus VR technology). The tablet is handled by the guide and, thanks to a Bluetooth connection, it controls simultaneously 6 Head-Mounted Displays (HMDs), provided to a small group of tourists at the beginning of the visit. The guide leads the tourist group through a planned itinerary, stopping in pre-established stages. The first step is located on the top of the so-called *Tanit* Hill, where the entire Nora peninsula can be seen and the virtual experience for the visitors can start in a bird's-eye perspective, with a real-time exploration of the current panoramas and the 3D reconstructions of the Phoenician settlement and the Roman city. Then, the visit continues, stopping on hot-spots placed in locations corresponding to the points of view of virtual reconstructions: here the guide asks the visitors to stand in line in the right position and to wear the HMDs; then the guide loads the correct reconstruction, connecting the tablet to their device. At this stage, the guide leaves the visitors free to spin around 360° and to enjoy the strong sense of three-dimensional ancient presence given by virtual reality (Bryson 1996, 62); at the same time, a narrative description of the reconstruction accompanies the experience, so the environment is described as a whole and details of reconstructions are underlined. At any time, the guide can check on the tablet what the single user is watching and so can shed light on any doubt or

Fig. 3 – Schematic representation of the *Nora Virtual Tour* system.

answer to specific questions. Afterwards, the guide invites the visitors to take off the HMDs, so the human eye can compare VR information with actual archaeological remains, in this way more easily perceptible and less open to misinterpretation (Hermon 2008, 39; Gabellone 2009).

The *Nora Virtual Tour*, a virtual visit in the physical ancient city, has an overall duration of 90 minutes, offering an experience longer than a traditional guided tour, which normally may last almost 45 minutes. The lengthened duration of the visit is not a cause of loss of attention, because the tourists are more engaged thanks to the use of VR devices, that are a new and catchy way of learning and communicating. Furthermore, the use of HMDs solves the trouble of the screen readability of tablets and smartphones in bright environments as an open area archaeological site, where displays reflect the almost direct sunlight.

The 3D model building of the ancient city started in late 2014, while the HD renders of the single monuments were completed in the first half of 2015. A beta version of the VR app has been released in early 2016; once the bugs were corrected and the software testing was performed, in July 2016 the training for specialized guides of the archaeological park of Nora begun and first test visits with tourists became possible (Fig. 4). The immediate and broad success of the *Nora Virtual Tour* among the visitors of the site and during events organized to promote innovative methods for the dissemination of cultural heritage (e.g. *Galileo Festival dell'Innovazione* in Padova, May 2016; *Museo Liquido Project* in Cagliari, June 2016, September 2016; *e-kphrasis International Seminar* in Ascoli Piceno, February 2017; *Salone del Restauro-Musei* in Ferrara, March 2017) confirmed the power of virtual reality to represent, communicate and transfer information collected by the scholars and usually hard to be understood for the general public. Thousands of users have tested the app with satisfaction, while symptoms of motion sickness

Fig. 4 – A Group of tourists led by a guide in the virtual visit of the so-called Roman Temple court (July 2016).

have been almost absent. The public interest for this cultural application of innovative technologies and the gained knowledge make *Nora Virtual Tour* a pilot project, that will be soon extended to other sites in Sardinia.

To summarize, the *Nora Virtual Tour* Project is a clear attempt to reconstruct a picture of ancient Nora and to communicate to the civic and touristic communities the history of the site, and as well as its transformations from Phoenician to Roman times. The case study helped us to understand how the virtual reality applied to cultural heritage gives the real opportunity to spread the scientific research within the general public and to enhance the archaeological sites, as Nora is, thanks to an innovative system fully appreciated by the public thanks to the immersive feeling. Furthermore, we can realize that the immersive techniques are proving to be more impressive to the user community than the better-known "flat" 3D reconstructions on screens and could clearly become the standard visualization way of the ancient buildings in the next future.

A.Z.

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ABSTRACT

The ancient city of Nora was a Phoenician, Punic and Roman settlement rising on a peninsula in the south-western coast of Sardinia. Since 1990, the University of Padova has been carrying on an interdisciplinary research project of excavation, architectural analysis, historical reconstruction and cultural promotion of tourism in this site. The excavations allow us to increase our knowledge of Middle Imperial Roman urban planning and to get a better understanding of the whole city and its history; the restoration of excavated monuments using gravels with different colours helps more than 60,000 tourists every year to recognize the function of different areas. In spite of this, visitors experience difficulty in understanding a landscape of ruins with barely visible evidence. Thus, a complete virtual reconstruction of the ancient city has become essential. 3D models of the Phoenician and Roman settlement have been developed, reshaping archaeological plans produced in 25 years by Universities that work in the site. The main monuments of the Roman city and the major crossroads have been rendered in greater detail, using sample-based textures that give a photorealistic effect and implementing the models with furniture and decorations selected through reliable sources of information. 3D reconstructions are now available for tourist groups led by a guide in the *Nora Virtual Tour*: stereoscopic images have been rendered and uploaded in an app for mobile headsets that provides immersive virtual reality for the users. The guide controls the devices with a tablet using a Bluetooth connection: at the beginning of the visit, the tourists can view equirectangular panoramas of the ruins taken from a helicopter, then they are accompanied to hot-spots where the ancient monuments are shown in an evocative Roman reconstruction.

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