# PORTUS LUPIAE. 3D MODELING AND VISUAL NARRATIVE FOR RECONSTRUCTING A LONG MARITIME HISTORY

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**Abstract:**

The fast evolution of digital technologies and techniques of data recording have had a great impact on archaeological research. The first effect of this revolution was an increased number of strongly technologically oriented projects and applications. Among all available solutions, the use of 3D models is particularly relevant for the reconstruction of sites and monuments poorly preserved, often destroyed by natural causes or human action. These digital replicas are, at the same time, a virtual environment that can be used as a tool for the interpretative hypotheses of archaeologists and an effective medium for a visual description of the cultural heritage as it crosses linguistic barriers. In this paper, methodology, aims and outcomes of a virtual reconstruction of the ancient harbour at St. Cataldo (Lecce, south Italy) carried out by *Portus Lupiae* Project of the University of Salento, are offered as case study for a virtual reconstruction of a long maritime activity. The use of 3D technologies for teaching and research as well as the post-processing and implementation of data generate a new digital workflow for sharing local culture.

**Key words:** 3D modeling, virtual heritage, ancient harbour, digital storytelling, drones, visual narrative

## 1. Introduction

Virtual Reality and 3D modeling have been applied to archaeology for more than three decades now (Remondino and Campana 2014). Much has been written on the potential of these tools for archaeological research (Niccolucci 2002) and most projects involving these technologies focus on the communicational aspects of 3D modeling in various media - internet, museum installations, etc. (Gabellone 2011), or technological improvements of 3D modeling tools and their use as a tool for scientific investigation (Hermon and Nikodem 2008).

The experience here presented regards a multidisciplinary research improved by the University of Salento to investigate the coastal area and the waters off the Bay of St. Cataldo, the main harbour of the Roman town of *Lupiae*, modern Lecce in southern Italy, and to further describe the construction of the coastal infrastructures and their historical context. The oldest pier is dated back by literary sources (Pausanias, *Description of Greece*, 6.19.9) to the era of Emperor Adrian, while archival documents provide detailed descriptions of the ancient structure up to the XVI century. The roman pier was reduced in size in 1901,

and the ancient construction material partially re-used in a twentieth-century breakwater that was directly founded on the earlier structure, and is still preserved in shallow water (Fig. 1).



**Figure 1:** General aerial view of the ancient harbour at St. Cataldo. A: the roman pier; B: the new breakwater.

The project "Portus Lupiae" started in 2009 as an experience of archaeological excavation, using different technologies such as aerial photo mapping, GPR survey,

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carbon-14 analysis, micropapaeonthological studies, computer vision and photogrammetry (Sammarco and Marchi 2012; Ferrari and Quarta in press). Starting point for this archaeological work was to collect all graphic and photographic documentation available for this monument, consisting mostly of archival documents, ancient maps (Fig. 2), historical photographs and publications from the 1880s.
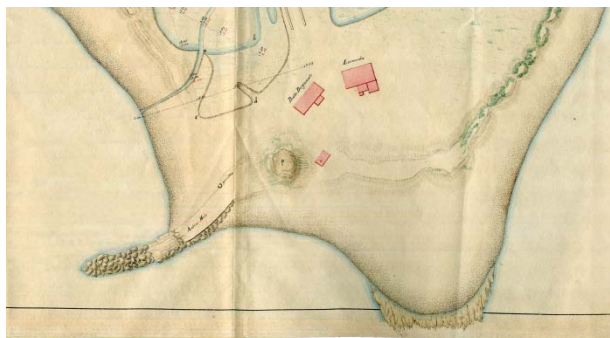


**Figure 2:** Detail of historical map (1881) showing the original bending shape of the roman pier (from State Archive of Lecce).

A two-years long archaeological excavation allowed to dig up the roman pier, that can be actually observed along the beach. The monument shows a compact structure and consists of two outer walls~15 m distant from each other (Fig. 3). The two curtains are made by large squared limestone blocks and filled with hydraulic concrete made with a strong mortar mixed with a local stone aggregate.



**Figure 3:** Current conditions of the roman pier.

The pier has been used until Middle Age, when it was a very active commercial port along the Adriatic coast. A significant trade activity is documented throughout the XVI and the XVII century, mostly to embark olive oil. When this activity decreased during the XVIII century, the harbour was progressively abandoned.

The new breakwater (Fig. 1) is L-shaped, begins at the root of the ancient pier and extends 190 m seaward. It laids on a wide submerged foundation consisting of large-size squared limestone blocks.

## 2. From field to screen: archaeological 3d modeling

### 2.1. The virtual model of the roman pier

First step for the digital modeling of the roman pier was to acquire a direct survey of the monument; then, an image-based 3D model developed using "structure for motion" argoritm has been realized (about 200 photos

have been taken, part of them by UAV platforms) using the software Agisoft PhotoScan.

This first phase of construction of the model triggered a cognitive process which allowed us to understand the complexity of the monument and its interaction with the ancient environment. A first question concerned the original planimetric extension of the structure; analyzing the ruins both emerged and submerged, currently ~140 m long, it was clear that the pier was much more longer and that it has been affected by continuous sea erosion process; no archaeological evidences could yet confirm how long the pier was in ancient time.

However, two architecturall features appeared to be definite: the slightly bending-shape and the width of the platform that increases in its advance into the sea. A further topic of discussion was the presence of two blocks projecting from the inside face of the pier ~75 cm, presenting circular-shaped holes ~33 cm in diameter. At first misinterpreted as mooring rings, these two blocks are placed 220 cm below the hypothetic quay floor and just above the sea level; furthermore, they do not present any traces due to rope rubbing.

Thus, the virtual model (Fig. 4) offered a interpretative sintesys showing these blocks used as support for wooden poles connected to machines for loading and unloading cargo from the ships.



**Figure 4:** 3D model of the pier of roman age; aerial view.

### 2.2. The virtual model of the modern pier and the underwater groundworks

The 3D model intended both to reconstruct in elevation the missing parts of the L-shaped breackwater and to rediscover digitally the massive underwater foundations well visible in shallow water (Fig. 5).
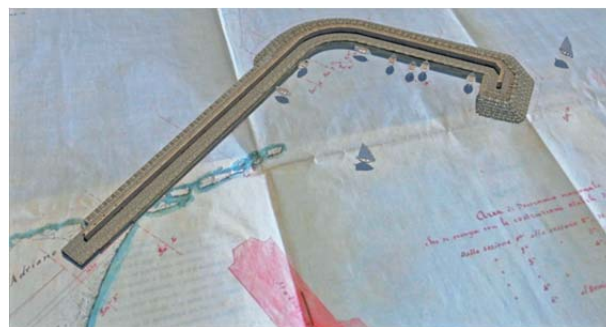


**Figure 5:** 3d model of the modern L-shaped breakwater; a project plan (1901) provides a ground to the virtual object.

The work tools used are Maxon Cinema 4D, a licensed cross-platform software for modeling, rendering and animation of interactive 3D contents, and Adobe After Effects for compositing and post-production.

In addition, historical maps have been elaborated to be used as a 'visualscape' for the location of the model. The

massive underwater groundworks has been rebuilt using the measurements provided in archival documents while the preserved outer walls were reconstructed using dimensions recorded on site and textured using photos taken on site, as well.

## 3. In progress: visual narrative and digital storytelling for reconstructing a long maritime history

The final outcome of the processing and post-processing phases is a 3.5-minute video, in which the virtually rebuilt harbour of St. Cataldo is shown in its landscape (Fig. 6). The visual narration starts with a controlled glide of the drone over the monument; adopting the wireframe technique the architectural evolutive pattern is shown. Then, gradually a realistic texture of building materials fade in, enhancing the perception of the structure and the realistic virtual model appears. A further phase of character animation (using profiles representing different people who operated there at the time) recreates work-activities bound with the port facilities. A narrator explains the progression of events.

We are currently working to develop a complete virtual timeline digitizing new contents (drawings, historical photographs, ancient maps ect.) usefull for designing the audiovisual narratives and making further 3D virtual models: a medieval tower, a chapel, the lighthouse. So, new shorter sections of this long maritime history will be written and replied into visual narrations.

## 4. Final observations

In conclusion, the virtual long life history of the ancient harbour of St. Cataldo, the main coastal outcome of the Roman town of Lupiae, modern Lecce (Italy) demonstrates how 3D modeling could be extremely useful for interpreting, monitoring and promotion of archaeological sites, offering a 'sixth sense' for understanding remains from the past.

The "digital experience" here reported offers a new creative perspective for local cultural heritage, presenting a mature interpretation of reality. By creating such virtual workflow of contents, we also intend to increase the access that general public has to the culturale heritage, promoting a better sharing and communication of archaeological and historical informations. The techniques applied enable the viewer to gain a variety of historical themes; that's why we assume that the outputs of this application are not limited to the mentioned heritage sites, rather the techniques could be applied to different multi-layered historical contexts.

## Acknowledgements

**Figure 6:** Visual synthesis of the narrativ process. The realistic model of the roman pier appers in its natural landscape.

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