From the dig to 3D reconstruction and AR dissemination. The case study of the Roman kiln of Massa (IT)

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1. The archaeological context

In connection with the P.I.U.S.S. upgrade and enhance of the historical architecture of Piazza Mazzini and Piazza Aranci, in the period from February to May 2012 have been carried out stratigraphic investigations, which covered about a third of the square from east-northeast to the west and stopping at the project’s levels.

In the roman period, Mazzini square was occupied by a production area with at least two kilns, one of which was investigated the combustion and firing chambers. The kiln, oriented towards south, was limited by a thick wall, built with large raw bricks become red-orange for the operation of the structure. From the combustion chamber, the heat was sucked up into the firing chamber through a thick clay grid floor (Kiln grille) mixed with fragments of pottery. The clay grid floor was supported by parallel arches in stone, set on the floor of the room below and arranged in two rows in order to create a central corridor. The parallelepiped structure, positioned in front of the entrance of the combustion chamber, was built by bricks over-burned with the function to distribute heat with the chimney positioned on the north. The combustion chamber was accessible from a little stoking aisle (prefurnium) in the south part, not explored,

![Fig.1 - The roman kiln during the archaeological excavation](image-url)
because it was located underneath the modern building. The kiln was covered with a temporary vault, built with clay and roof tiles placed directly on the walls, which was demolished every time after the cooking of pottery. The materials found, mainly Italic amphorae for wine, allow us to date the use of the complex between the end of the II and the half of the I century BC and put in relation with agricultural structures in the Apuan hills behind the ancient city of Luni.

2. Survey and 3D reconstruction

The survey of the kiln was performed using imaged based technique based on a multistereo view reconstruction approach. Multistereo view reconstruction is an innovative sector in the 3D scanning technology. During the last few years this approach has been developed and almost consolidated. It takes advantage of procedures that allow 3D models to be obtain from a set of uncalibrated photos taken from different prospectives. The entire process is carried out automatically by software that combines algorithms of computer vision in order to obtain 3D models. The automatic approach of this method implies a lower precision in comparison with other conventional scanning techniques, nevertheless, recent studies have demonstrated that this approach can be sufficient reliable and usable for some archaeological purposes [Callieri et al., 2011]. In order to survey the kiln, the photographic campaign was carried using a common digital camera. The area around the monument was free of obstacles, so each photo was taken without problems from different prospectives, covering almost the entire archaeological area. In order to get a topographic network as a reference system for post processing operation, the excavated area was surveyed using a laser total station. The computing operations, to derive the 3D model of the kiln from photos, were carried out using Photoscan Agisoft software. Then the model was imported as mesh into MeshLab software both for postprocessing operations - such as mesh cleaning and scaling - and for deriving rectified plans for archaeological documentation. The following step was the reconstruction of the Kiln using 3D graphic software to produce images and a short film. The reconstructive hypothesis was created using the scanned model as reference and basing on the historical and archeological data available for this kind of monuments. The reconstructive hypothesis put forward, was discussed and validated in collaboration with experts in this archaeological domain. As mentioned, the goal of this project was cultural dissemination. Therefore the 3D model of the kiln was integrated with its adjacent workshop and the presence of artisans involved in the working activities (turning, firing, backing, warehousing, etc.) in order to simulate the operating principles of the furnace and its surrounding area to the general public. Finally, textures, material and lighting were added to the models for improving the realism of the scene.

3. Environment reconstruction

The contextualization of the kiln in its present shape, was the major goal both for communication purposes and for research interests. During the excavations remains of the kilns were unveiled under the paving and were very difficult to decode without a complete sight of the actual context and its consequen-
Fig. 2 - The steps performed by Photoscan software to obtain the reality-based model of the kiln.

a) estimation of the camera information and positions and point cloud generation; b) triangulation and mesh generation; c) texture creation from oriented cameras
Fig. 3 - 3D reconstruction of the kiln based on interpretations put forward by experts. The modeling processes were performed using Blender, a computer graphic software.

The ancient landscape was reconstructed starting from the geographic conformation of this area (closed between the Alpi Apuane Mountains and the Arcipelago Toscano sea, Monte Marcello, fiume Magra) being an "evocative" level of reconstruction [Scaglia

Fig. 4 - 3D hypothetical reconstruction of the kiln as it was in the Roman time and simulation of loading operations.
4. Communicate archaeology: short video and mobile app for smartphone and tablets

The 3d models of the actual square and the reconstruction of the kiln as we suppose it was in the roman time (II-I B.C.), were the starting point for two different communication solutions: a short video and a mobile App.

- The video describes in few minutes the operative principle of the kiln and its surrounding working area (people involved, daily activities, etc.) and clarifies its position in the actual square.

- The app for smartphone and tablets on the other hand is based on Augmented Reality techniques and has been designed and customized for on-site use. After the archaeological excavation was immediately clear the need for a non-traditional, alternative way to musealize the site context. In fact, the mu-
sealization of the kiln was quite problematic. As access to the kiln after exca-
vation was no longer possible, due to the fact that the kiln was buried again to
conserve it and to allow the urban traffic. Therefore the Massa’s Municipality
(Comune di Massa) has funded our AR solution as a concrete way to explore
and enjoy with the disappeared kiln, giving the public the possibility of a virtual
visit of the monument. The user interacts with panels located in the Mazzini
square in Massa: once one of the images on the panel is focuses, a 3d event
will show the correspondent reconstruction allowing to explore it just moving
around with the device. The on-site AR reconstruction shows “validated” 3d
models and its impact is both emotional and accurate from a scientific-co-
munication point of view. After the project was completed a video-paper was
made to visually explain the project’s workflow [Cerato et Alii 2013].

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