

The Contribution Of The 3D Study For New Reconstructive Proposals Of Lecce In Roman Age

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Abstract – This contribution concerns, in particular, the study of the two most important monuments of ancient Roman Lupiae: the amphitheater and the theater, whose remains, now incorporated in the modern urban fabric, can still be seen and visited only partially. Despite the evidence of the monumental ruins still visible, there is the impossibility for the visitor to perceive their actual size, both in plan and elevation. At the moment there are no information boards and didactic aids to understand the complete aspect of the two monuments how they could appear in ancient. The realization of accurate reconstructive proposals starting from the laser surveys, as well as the application of technologies that utilize Image-Based algorithms SfM (Structure from Motion), have

been aimed at the realization of different outputs to facilitate the visit in situ of the two monuments, with different ways of reading.

Applications of semi-AR in addition with stereoscopic narratives allow to understand the characteristics of architectural-construction not clearly understood, but rather to make readable reconstructions both within their original context, both superimposed over modern city. An approach useful to provide a sense of the scale of buildings. In this process of study, the contribution of 3D modeling software it is not confined to the pure generation and manipulation of polygons in the space, but it is crucial to facilitate the processes of interpretation.



Fig. 1. The reconstruction of ancient Lupiae.

I. AIMS OF THE RESEARCH

One of the main singularity within sites with continuity of life, is the architectural stratification, which developed over the centuries, in line with the needs and styles typical of individual historical phases, slowly but surely distorts the urban skyline. Despite this, the presence, the excavation and the rediscovery of the ancient structures in the subsoil, pose the question of how cities should arise and characterize in a specific historical moment with the main architectural and urban features visible in their entirety. In this article we present the results achieved by IITLab IBAM CNR within the DiCet project, which pursues the objective of creating a platform enabling the processes of sustainable development for a smart city, based on the spread of knowledge and on an innovative model for the correct use and enhancement of the cultural heritage. DiCet is based on a social innovation approach, where the services are co-created involving all actors of an ecosystem oriented towards smart culture and tourism (companies, research, public authorities, end users).



Fig. 2. The amphitheatre in their ancient context.

This contribution concerns, in particular, the study of the two most important monuments of ancient Roman Lupiae: the amphitheater and the theater, whose remains, now incorporated in the modern urban fabric, can still be seen and visited only partially. Despite the evidence of the monumental ruins still visible, there is the impossibility for the visitor to perceive their actual size, both in plan and elevation. At the moment there are no information boards and didactic aids to understand the complete aspect of the two monuments how they could appear in ancient.

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original context, both superimposed over modern city. An approach useful to provide a sense of the scale of buildings.

II. THE AMPHITHEATRE

In this process of study, the contribution of 3D modelling software it is not confined to the pure generation and manipulation of polygons in the space, but it is crucial to facilitate the processes of interpretation. Many arguments about balance of proportions, the juxtaposition of volumes, the application of the laws of statics, would certainly not be possible in the short times imposed by many projects, nor would it be easy to address these issues on a large scale, with traditional drawing methods. So it is important to recognize the significant contribution given by 3D modeling software to the study of ancient monuments. Knowledge of the three-dimensional architectural structures provided by the 3D modelling allows to deepen and monitor efficiently the different phases of reconstruction, with significant increases on accuracy, on productivity and on the ability to answer to the specific problems imposed by the observation and study of the monuments directly in 3D space.

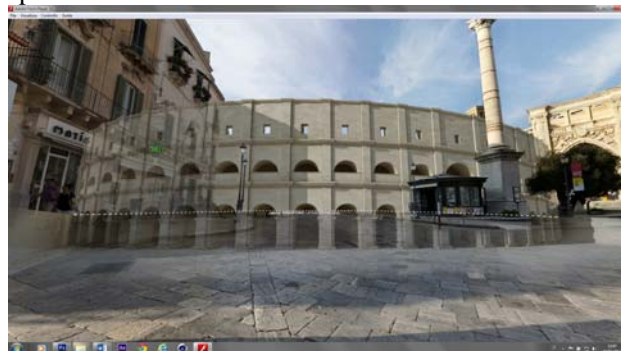


Fig. 3. The amphitheater superimposed over actual city.

The case of the amphitheater of Lecce is a clear example related to this issue.

Many archaeologists have supported the idea of an architectural complex with only two orders, not so much for objective conclusions depending from a study based on a metric survey, but for generic convictions related to the importance of the city among the roman colonies in imperial age. In fact some constructive elements observed in situ provide a different solution already from at first sight. But we proceed with order.

From 1938 to 1940, the Soprintendenza ai Monumenti e alle Antichità della Puglia (Superintendency of the Monuments and Antiquities of Apulia) undertook the excavation and restoration work that brought the monument to its current appearance. The dating of the monument has for a long time been a matter of debate, although a series of indications and documents now point to the Augustan period, with probable restructuring and improvements constituted by the *porticus in summa*

cavea, most likely placed in the Hadrianic period. This second phase of construction would be confirmed by the capitals in Pentelic marble, of Pergamonic type and produced by Greek workers, and perhaps by the reliefs on the parapet around the arena, featuring lively but crude scenes of *venationes*. These consist of a series of bas-relief work featuring scenes of fighting between wild beasts and of men attacking animals. As well as those native to the Italian peninsula, there are exotic creatures such as panthers and lions that would have appeared in Rome after the Punic Wars and the conquest of the African territories. Today, only a third of the ancient edifice is visible.



Fig. 4. The remains of an arch in the second order.



Fig. 5. The actual *cavea* with the remains of *vomitoria*, is clear the impossibility of *praecinctio*.

Nonetheless, we are able to comprehend from this the monumentality and the importance that it must have had in the Roman city of 2,000 years ago.

Planimetrically, the amphitheatre has been designed and built in four distinct sections, punctuated by four entrances, organised symmetrically along the axes. The tall construction is based on modular repetitions of three grouped arches, regularly appearing along the elliptical perimeter of the arena, which provided, respectively, access via stairway to the upper ambulatory, the lower ambulatory, and to an enclosed space with level paving,

presumably reserved for utilities: dressing rooms, stores, cupboards. The modular design reappears in the distribution of the stairways connecting the lower ambulatory and *ima cavea*, upper ambulatory and *media cavea*, perimetric portico and *summa cavea*, arranged in such a way as to encourage movement of spectators in a double series of oblique paths. For service purposes only, however, were the six passages, laid out in axes and likewise with access to the outside, that led between the lower ambulatory and the arena. These allowed access to the surrounding narrow cuniculus, which was certainly created to meet the drainage needs of the entire building. The conglomerate structures feature reticulated facades in blocks of Lecce stone, while the core is made from a mixture of fat lime mortar, sand and imported pozzolana, and includes flakes of Lecce stone. In the vaults, all of which are constructed in barrel form, pumice and volcanic slag – certainly imported – have been used. The building measured 102 by 83 metres externally, with an arena of 53 by 54 metres, and could hold between 12,000 and 14,000 people.

III. CASE STUDIES

In order to perform an accurate reconstruction of the monument they were carried out surveys integrated with two different techniques: laser scanning and image-based survey. The use of the two techniques is motivated by the need to get an accurate model thanks to the precision of the active sensor. The limited number of shots, in laser scanner capture, reduces the residual error affected by the registration process. The comparison between the two techniques (laser-IB) allows to consider measurement errors produced by photogrammetric technique, which as you know is more sensitive problem caused by the photographic coverage, the picture resolution, the high ISO values, etc. The Image Based technique, on the other hand, generate model complete with texture and this is extremely important to understand the construction techniques and to identify the modern parts made with the architectural restoration. The study of the morphology of this monument has highlighted some interesting aspects, in particular some fundamental elements were taken into consideration:

1. The slope and the morphology of the *cavea*;
2. The presence of an arc still visible in the second order, placed in correspondence of the inner wall of the external *ambulacrum*;
3. The morphology of the arches of the first order;
4. The location and the morphology of the *vomitoria*.

The slope of the *cavea* suggests the extension of the stairs and their ideal intersection with the outer perimeter of the building. The study allowed us to compare the ideal slope, obtained by extending that observable today, with the height of the vaulted roof of the external ambulatory

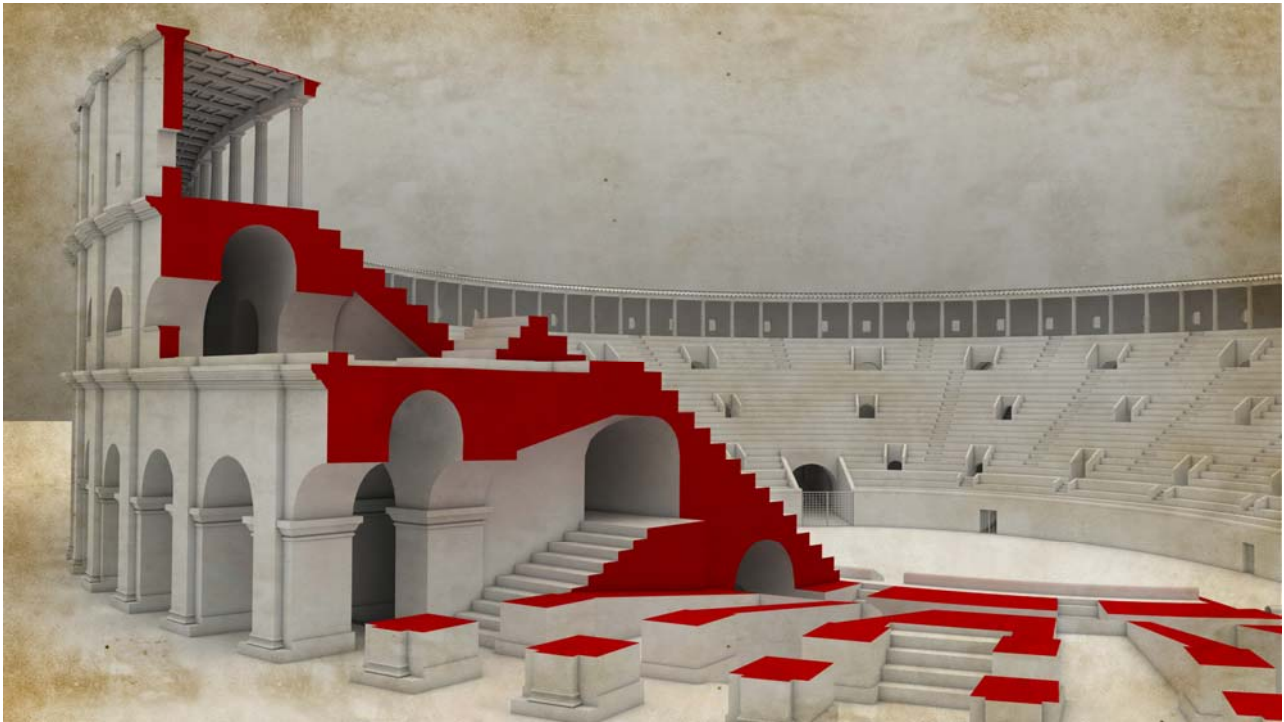


Fig. 6. Section shows the structure and distribution of the amphitheatre

in the second order. This vaulted roof is perfectly compatible with the slope proposed in our proposal reconstruction. It simultaneously excludes an height greater than the arches, which are incompatible with the morphology of the stairs. The last large step today observed in the surveys, don't shows traces of a *praecintio*, that would be compatible with an elevation gain of the cavea, such as to justify an increase of more than one meter of the arches in the second order.

The reconstructive proposal presented here consider the singularity found in the survey. The arches in the second order are lower than those present in the first order.

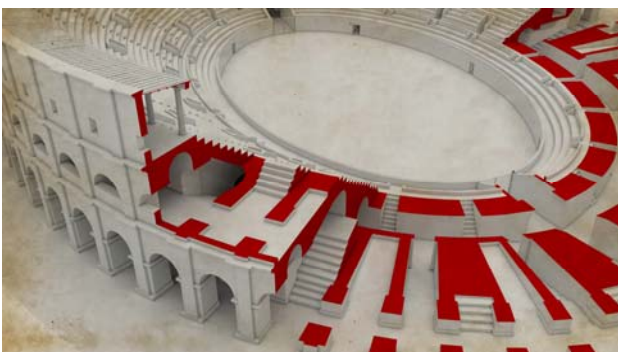


Fig. 7. Structure and distribution of the amphitheatre.

The discovery of some capitals (type *Pergameno* in Pentelic marble) suggests to allocate them in the *porticus in summa cavea*, in accordance with a diffused Roman tipology for this kind of monument.

The 3D study conducted on the metric basis has allowed to do numerous checks also on constructive characteristics, in order to evaluate the wall thickness, the thicknesses of the conglomerate vaults, the floor levels and each other constructive element placed in direct or indirect relation with these. In practice, with the 3D approach it was made a digital copy of the main structural elements, that simulating the entire construction and evaluate in virtual form the technical and functional coherence of the building in relation to the construction principles in the Roman age and to the laws of statics.

We often find ourselves dealing with sites that provide only fragmentary and patchy information that, although extremely important and precious on the scientific level, is often not enough to formulate realistic reconstruction hypotheses. To be sure, reconstruction must always grapple on various levels with missing data, because the rarest circumstance is precisely the one in which the available data are abundant and sufficient for defining with certainty a scientifically unassailable and unambiguous proposal. That said, there is no denying the charm of attempting to “imagine” possible solutions of use for nourishing a constructive debate on what buildings looked like in the past. The reconstructive study thus proceeds without sacrifices, pooling many data that although apparently negligible, are indispensable when there are so few in number. The analysis continuously weighs them on the technological and functional level, making an effort to find a plausible reason for their existence. The most important aspect of this approach is



Fig. 8. 3D model of the perimeter structures.

to proceed with reliable elements and interpretations that, by chain reaction, might yield consequent effects and therefore deductions linked to a “logical and analogical” process. It is logical because it refers in fact to universal rules and principles of good construction; it is analogical because it proceeds through comparison and analogy.

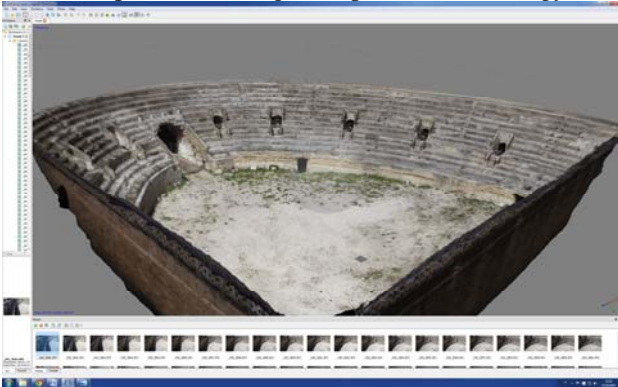


Fig. 9. The actual cavea within the PhotoScan sw.

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Fig. 10. Final reconstructive proposal