RESEARCH ON THE THEATRE AT HIERAPOLIS IN PHRYGIA:
AN INTEGRATED APPROACH

Filippo Masino – Giorgio Sobrà – Francesco Gabellone – Massimo Limoncelli

Since 2004 the Theatre at Hierapolis in Phrygia has been the centre of a new research programme, led by Prof. Dr. Francesco D’Andria of Università del Salento, that incorporates architectural study, restorations and the monument’s presentation to the public.

The programme has been conducted by the architectural historians from Politecnico di Torino and experts in 3D modelling and graphical restoration from IBAM-Lecce.

ILLUSTRATIONS OF THE RUINS AND GRAPHICAL RECONSTRUCTIONS IN THE PAST

In the Theatre at Hierapolis, which was constructed under the reign of Augustus, the old scaenae frons was replaced during the early 3rd century by a new, more monumental one. The new columnar façade was organized on three storeys and flanked by two imposing paraskenia. Sculptural reliefs, displaying mythological subjects, were placed on the different storeys, while dedicatory inscriptions ran along the entablatures. The transformation was outstanding due to the size of the structures, the high quality of workmanship and materials employed.

An earthquake in Hierapolis in the 7th century caused the collapse of the entire building as well as the ultimate abandonment of the city. Since the 18th century, the monument’s striking ruins have become a recurrent theme in European travellers’ descriptions and engravings.

Many splendid drawings from the 19th century illustrate the ruins of the Theatre at Hierapolis that have been observed from the top of the cavea and placed in the suggestive landscape of the valley of the Meander. The drawings are often used by scholars due to the detailed representation of the architectural structures and the individual blocks that remain in position after the collapse. However, they often show errors or approximations in the representation. This may be due to their production for publication, which was often finished at home and on the basis of drafts taken on the site.

Approximately ninety percent of the marble fragments of the columnar structure were preserved in the cavea. Its subsequent ancient appearance has attracted several scholars. The first graphical representation was made by the Italian architect Giovanni Battista Borra during an expedition to Palmyra that was led by Robert Wood (1750-53) and stopped at the Theatre at Hiera-
polis. Borra was most likely impressed by the rich decoration of the ancient architectural blocks of the *scaenae frons* and thus made detailed representations of elements, such as the central door frame, the jamb of a side door, the entablature of the second storey and a strigil-fluted column shaft with a composite capital.6

The first photographs of the Theatre were published by Pierre Trémaux in 1863 as well as drawings of some blocks and their possible reassembly. He was also the first scholar who tried to graphically reconstruct the whole monument through a general plan, a cross-section and a plan of the second storey.7 Although his proposal was largely ill-founded, it still, until very recently, influenced studies on the Theatre.8

The members of the German expedition to Hierapolis in 1887 mainly focused on the epigraphy. Certain measurements of the inscribed blocks of the Theatre were published under the names of the participants.9

Until then, all documentation had been exclusively based on the observation of the blocks lying in the upper layer of the collapsed structure and of the wall structures preserved. The systematic excavation did not start until the Italian Mission in 1957. Daria De Bernardi Ferrero coordinated the instrumental geometric survey of the entire building and thousands of marble elements were moved outside the *cavea*, measured and inserted into a huge data-base. In the meantime, the epigraphic studies made by Tullia Ritti and the studies on the sculptural reliefs of the podia clarified the sequence of many blocks and provided indepth knowledge of the iconographical programme.10 The first general graphic reconstruction was published in

---

6 Despite all the data collected during this expedition, the part regarding Asia Minor was not published: concerning the Theatre at Hierapolis see the words by Wood in his diaries (nowadays in the Library of the Society for the Promotion of Hellenic Studies, London) [HUTTON 1927, p. 119]; and the drawings by Borra (currently stored in the Yale Center for British Art, New Haven – Connecticut) [WILCOX 2001; ZOLLER 1996, pl. 18.12].

7 TREMAUX 1862–1868, pl. 5, 7, 8, 11, 12. See note 5.

8 His interpretation of the blocks with Hadrianic inscriptions as part of a *porticus in summa gradatione*, for example, has been considered a proper intuition and maintained in its general principle in every publication concerning the Theatre until 2007. Recent studies have clarified that these blocks belong instead to a Monumental Altar dedicated to the Twelve Gods of the City [MASINO; SOBRÁ (in press)].

9 HUMANN; CHICORIUS; JUDEICH; WINTER 1898 (in part. 60–65)

10 RITTI 1985, p. 108–113; D’ANDRIA; RITTI 1985
2002\textsuperscript{11} and illustrated the general layout of the façade and, despite its schematic approach and estimations, it provided the fundamental basis for further studies. (F.M.)

**ANALYSIS AND RECONSTRUCTION OF THE MONUMENT**

The research that has been conducted by our group since 2004 has focused on the stage building, its marble decoration and its inner functional organization and has sought to achieve an ultimate reconstruction of the Severan *scaenae frons*.

Due to the lack of documentation for the excavation of the *cavea*, the study has been based on a depth analysis of the elements preserved in situ and in the store yards. In particular, we analyzed the different typological groups of elements and prepared a large number of sketches of the prominent blocks, using colours and symbols to indicate their main features:

- types of marble\textsuperscript{12};
- different treatments applied to the surfaces;
- traces of the assemblage system of the blocks (pivots holes, seats for iron clamps, holes for the insertion of lifting means e.g.);
- characters of the decoration, especially outlining the presence of unusual or unfinished items and the variations in the execution of the iconographic patterns.

A key step for the study of the ancient building has been the formulation of working hypotheses about its shape, the relationship between the different marble blocks and the different possibilities of their assembly. The large production of free-hand sketches that were made on site, often produced quickly and with several approximations, has therefore been an integral part of our work. Subsequently, the collected data were transferred into CAD drawings and presented to the scientific community.\textsuperscript{13} This equally dynamic and attentive approach enabled us to recognize the exact sequences of a large part of the blocks, to formulate hypotheses that were different from those previously published and allowed for an elaboration of newsworthy remarks on the building process.\textsuperscript{14}

In 2007, a synergic collaboration between the architectural historians and the experts of the IBAM was established. Our group carried out an attentive supervision of the modelling process to ensure the matching between the 3D reconstruction and the results of the analyses. The first 3D model was completed in 2007 and was used as a preliminary working sketch to be updated in further studies. In addition, it has been used

\textsuperscript{11} [CERESA 2002, p. 64] In particular, the reconstruction by De Bernardi had a typological character, suggesting the general layout of the columnar structure basing on the sequences of the inscribed entablatures of the first and second order and on some statistical considerations about the consistency of the different types of architectural elements, but without taking into account all the blocks preserved. Another drawing has been published in [DE BERNARDI 2007, pl. XX], with some variations.

\textsuperscript{12} The marbles used for the construction of the *scaenae frons* came mostly from quarries near the city, such as those in Thiountas and Laodikeia, or from those far more distant from it, such as Aphrodisias and, less frequently, Dokimion (Afyon) [PENSABENE 2007, p. 294–302]. The data derived from the autoptic examination of the stone materials have been useful in identifying the mutual compatibility of some fragments and the position of full blocks [MASINO; SOBRÁ 2010].

\textsuperscript{13} The results of these studies were presented for the first time in the symposium "Methodologies of restoration and enhancement of Ancient Theatres in Turkey", Karahayit-Pamukkale – 7 and 8 September 2007.

\textsuperscript{14} For example, the analysis of the decoration showed that at least two different teams or workshops may have operated in the Theatre, one in the southern half, and one in the northern half [MASINO; SOBRÁ 2010].
for the composition of didactic panels, simulations and photomontages utilized for the presentation of the project of anastylosis of the first order of the scaenae frons that has been recently approved and financed by the Turkish Government.\(^15\)

The ongoing collaboration between us and IBAM, both on the site and in Italy, allowed for regular updates of the 3D model of the building. The most recent research has helped us to increase the knowledge of the material preserved by means of a publication on a new reconstruction of the scaenae frons. Here, all sculptural reliefs have been placed and the architecture of the two large paraskenia, that flank the stage and whose size and decoration have created an unicum in Asia Minor, has been clarified.

The integrated approach of the two research units has played an extremely positive role in the studies: the special attention to the relationship between the wall structure and the architectural decoration that was required by the 3D modelling, has been a fertile phase of verification and implementation of the knowledge concerning the monument. (G.S.)

THE VIRTUAL RESTORATION OF THE THEATRE IN HIERAPOLIS

The reconstructive study of the scaenae of the Theatre has been conducted with regards to a procedure that has been widely applied in the field of Virtual Archaeology\(^16\) and Virtual Restoration\(^17\). Using integrated Computer Graphics methods, the archaeological approach to reconstructive studies seeks to create a virtual three-dimensional model, in which all the information provided by the various disciplines involved in archaeological research converges into a single “knowledge model”.

The main characteristic of an architectural artefact is the series of close relations between materials and structures – structure and function – function and form – form and style – style and materials, which provide the foundation for its creation.\(^18\) Due to Virtual Restoration, information technology enables us to create a three-dimensional reproduction of an archaeological or architectural item, via innovative and immersive forms of visualisation that present it to us as complete (or nearly complete) and integral constructions.

In Virtual Archaeology, 3D reproduction is no longer seen as a way of achieving an ideal reconstruction of an architectural item, but rather as a method for the verification and the merging of analytical data collected from studies of the functional and structural logic of a building. Another aspect of Virtual Restoration is the understanding of the so-called “technology aspect”.\(^19\) The starting point is the consideration of the theatre with regards to what anthropologists call “the technical objective” of the builder.\(^20\) This refers to the aim of the individual or individuals who, in a coordinated series of operations and as their ultimate goal, sought to build a structure. Considered in this way, none of

\(^{15}\) Coordination of the project: Prof. F. D’Andria; design team: Arch. P. Mighetto, Eng. F. Galvagno; historical analyses: Arch. F. Masino, Arch. G. Sobrà.


\(^{17}\) BENNARDI-FURIERI 2007

\(^{18}\) MANNONI 2000, p.9

\(^{19}\) BIANCHI 1996, p. 53

\(^{20}\) ANGIONI 1984, p. 63
the phases of construction is the result of a random choice. Instead, each operation directly reflects both the technical knowledge of the builders and the cultural and economic situation of those who commissioned the building. Reconstructive study can also be seen as a form of ethnoanthropological analysis that seeks to understand “the relationship between the evidence of the buildings themselves and the dynamics of the relevant technological and cognitive processes, as well as the mechanisms of transmission of such knowledge, and their link to the cultural environment and the political and social organisation of the time.”

The Virtual Hierapolis project also includes the study of the production cycle and the building materials. This includes developing hypotheses concerning the decision-making about the acquisition of supplies, the initial processing of the materials, their improvements made on site and during the construction of the structure itself, and the choice of exactly what to build. In short, it incorporates the various phases of the construction process, known as constructive activities that have been envisaged in the architectural project.

In terms of the methodology of reconstructive study, one must first conduct a documentation of the current state of the building and then gather all the information that is still retrievable from a direct analysis of the architectural item. This includes the data from the archaeological excavation, the analysis of the individual architectural elements and the direct or indirect survey of the building. Once all the information has been obtained, the second step involves a shift from the survey to the 3D restitution. This is carried out with the creation of one or more three-dimensional virtual models of the individual historic phases of the buildings by employing the Hand Made Modelling technique (solid and polygonal modelling, nurbs, subdivision surfaces, etc). In this phase particular attention has to be paid to the texturing, such as the application of the materials to the objects that constitute the model. In our case a photographic survey was conducted in order to sample all the materials used in the construction and to create a restitution that not only demonstrates the volumetric and spatial appearance of the building, but also highlights its aesthetic appearance. Here, the relationship between the materials, their colours and the decorations all help the viewer to gain a greater understanding of the architectural composition of the original project.

The reading of a monument via 3D modelling is thus a necessary premise for understanding the object’s history. Unlike a three-dimensional drawing, 3D modelling enables the viewer to virtually enter the internal space of the monument, which is a key characteristic of architectural perception. Three-dimensional virtual models thus represent the last stage of a chain of inquiry and constitute a point of convergence and a rigorous method for verifying the scientific data that have been obtained by historical and archaeological research. In addition, 3D modelling makes it possible to comprehend the original architectural plans via the technical analysis of the building.

Regarding the Theatre of Hierapolis, whose study is still in progress and thus subject to subsequent modifications, the main difficulties in the creation of the 3D model were the considerable quantity of architectural elements that were to be modelled. This resulted in a model composed of 7000 objects with a total of more than 11 million polygons. Due to the quantity of polygons, it was not possible to model the form of each

21 BIANCHI 1996, p. 53
22 CAGNANA 2000, p. 21
individual architectural element in detail. This was particularly true for the capitals, architraves and door jambs, the cornices and the figurative reliefs found on the podium of the stage, above the architrave of the first order of the scenaes and along the two lateral versurae. This technical problem was overcome by using texturing and rendering algorithms, including bump and displacement, which provided the model with geometric precision and a perception of the original architectural forms. (M.L.)

THEATRE AT HIERAPOLIS: A HOLISTIC APPROACH TO RECONSTRUCTIVE STUDY

The holistic philosophy is based on the idea that the properties of a system – ranging from microscopic particles to the most complex stellar systems – should be considered as a whole. In other words, particular systems or organisations cannot be explained exclusively through the analysis of their individual components. The specific nature of an object thus derives from the interaction and the relations between its components. This interaction is synergic and generates "emergent properties," such as new possibilities and values that are not predictable from the characteristics of their separate parts. Taking steel as an example, one can notice that its resistance to traction is far more superior in total than the individual resistance to traction of its components iron and nickel. Bearing this in mind, this approach may be termed holistic: the functional sum of the object's elements is always greater (or at least different to) the sum of its individual components. A typical example of a holistic structure is the biological organism: a living being should always be considered as a whole that cannot be expressed by the sum of its individual parts. Recently, it has been argued that the study of Cultural Heritage does not deal with static entities. Instead, considering the continuous discovery of new finds, scholars must regularly revise what seemed to be certainties. Thus Cultural Heritage can no longer be perceived as the sum of a number of individual objects, kept and catalogued in museums or collections and without a link to the historic and social context. The very mechanisms and evidence on which the proposed interpretation of a datum is based must be clearly described and presented to the wider public. This allows for a clear definition of the research process and the fact that the public can be involved in the assessment and interpretation of an archaeological find and its relevant reconstruction. These considerations prompt a reflection on the study of ancient monuments – also described as complex and intricate creations that form the basis of a Cultural Heritage object that has been constructed by human beings through the addition of juxtaposed and connected elements. Such elements are organised in a way that allows for an elevation to "architectural organisms," which, just like organic forms, are incorporated into this holistic vision. This clearly refers to cities, roads, monuments, houses and settlements, in which the approaches towards the construction are repeated and it is evident that they belong to one domain. The city is clearly a "domain" in which a holistic vision finds full application: the construction of a building generates unique conditions that influence the adjacent as well as subsequent constructions. The basic architectural elements, such as cornices, capitals and columns, refer to an overarching "idea of the city." Thus the task of reconstructing an ancient building must necessarily encompass the interpretation and the study of the entire urban complex. This includes the identification and representation of the "idea of the city," which is composed of individual buildings. The results of this reconstructive study show that the Theatre of Hierapolis is highly representative of those expressive and historical features that we find in all monuments of the city. Thus, in congruence with the theatre, the overall physiognomy of the entire ancient context begins to take shape: Virtual Hierapolis is an interdisciplinary study and representation project based on Virtual Reality systems, which includes the Nymphaeum of the Tritons, "Frontinus Street," the Martyrion of Saint Philip, the Stoà-Basilica, the marble Stoà, etc.

The construction of a VR-based knowledge system presupposes that the connections between items (in our case individual monuments) and their fundamental coherence will facilitate intelligent or cognition-based behaviour, which in turn enables even non-expert users to grasp the "idea of the city" and the cultural identity that is reflected by these items. However, the holistic approach, such as the one that is based on an understanding of the monuments considered together, does not preclude the possibility of using an inductive method, which proceeds from the detail to the general picture to find solutions to specific interpretative problems. The reconstruction of the theatre, as described below, was accomplished by "digital anastylosis." This involves the three-dimensional restitution of the individual architectural and sculptural elements that are detectable. Each of these elements has been re-processed in three dimensions using NURBS modelling (Non Uniform Rational Beta Spline) and Subdivision Surfaces. The detailed two-dimensional survey drawings was used as a starting point.

Regarding the Theatre, although the quantity of collapsed architectural elements is sufficient for the formulation of a plausible reconstructive hypothesis, the fragmented nature of the surviving pieces and in some cases (fortunately rare) the total absence of the originals poses a problem. The reconstruction of ancient contexts characteristically faces serious problems of reliability.

23 SMUTS 1926
24 ROSS 1978
25 GABELLONE 2009
caused by the more or less fragmentary information concerning the original appearance of a monument. In addition to the hyper-realistic reconstructive proposal, we have therefore presented a correspondence model of the original elements. It will enable scholars to retrace the criteria used for the reconstruction and to formulate alternative proposals. Hopefully it will also help soften the diffidence that is occasionally demonstrated towards 3D technologies that are frequently cited in reconstructive proposals.

(F.G.)

Address:
Filippo Masino, Giorgio Sobrà, Politecnico di Torino, Dipartimento Casa – Città, Viale Mattioli 39, 10125 Torino, Italia
E-Mail: filippo.masino@polito.it, giorgio.sobra@polito.it

E-Mail: f.gabellone@ibam.cnr.it, max.limoncelli@libero.it

List of figures:
Fig.1: [DE LABORDE 1838, p. 83, pl. XXXIV]
Fig. 2 – 6: authors

Bibliography: