

## A VIRTUAL THEMATIC MUSEUM OF THE *TERRA D'OTRANTO* LIGHTHOUSES BASED ON A LOW COST METHODOLOGY

F. Gabellone, A. Monte

CNR - IBAM (Institute for Archaeological and Monumental Heritage – Lecce)

C/o Villa Tresca – Campus Universitario, via Monteroni 73100 Lecce (Italy) f.gabellone@ibam.cnr.it , a.monte@ibam.cnr.it

**KEY WORDS:** Industrial Heritage, Lighthouses, 3D, Virtual Reality, Photogrammetry,

### ABSTRACT

Lighthouses are considered part of our industrial heritage in that they are an infrastructure at the service of navigation, an indispensable nocturnal signalling system for navigators and a useful landmark for both maritime and air traffic.

The lighthouses in question belong to the *Demanio Marittimo Militare*, a department of the Italian Navy. They are still relatively unknown and above all they are not easily accessible. For decades now numerous lighthouses, including the buildings around them used by the lighthouse managers, have stopped working and have been completely decommissioned and abandoned. For this reason it was considered useful to conduct a scientific study of this valuable form of heritage linked to the navigation industry, in order to obtain first-hand knowledge of it and to highlight its true value.

The work focuses on the study of four lighthouses located in Puglia in the South-East of Italy, in the area formerly known as Terra d'Otranto (covering the modern-day provinces of Lecce, Brindisi and Taranto). The lighthouses studied include those of San Cataldo (near Lecce), Punta Palascia (near Capo d'Otranto, the most easterly point of Italy), Capo Santa Maria di Leuca and the island of Sant'Andrea near Gallipoli.

From the methodological point of view, the present study is an example of a *low-cost* approach to the problem of documenting and promoting archaeological and architectural heritage items. Specifically, the aim is to create a DVR (*Desktop Virtual Reality*) platform to enable the public to enjoy heterogeneous digital content at a distance, available both on-line and off-line, derived from the study of architectural characteristics and the analysis of existing documentation on the Terra d'Otranto lighthouses. The individual items under study were surveyed using Digital Photogrammetry (Photo-modelling) techniques and re-created in three dimensions. All the data available (archival, bibliographical, photographic, iconographic, etc.) are connected to the three-dimensional object, which thus constitutes the informational basis of the entire platform, conceived as a 3D DataBase.

The ultimate objective is to find a valid methodological framework for the creation of a virtual thematic museum, or "Lighthouse Museum", starting with the site on the island of Sant'Andrea near Gallipoli, home of a now decommissioned lighthouse, but also a site of considerable historic, archaeological and environmental importance.

### 1. INTRODUCTION

The research (still in progress) presented here focuses on the study of lighthouses situated in the far South of Italy, in Puglia, in the ancient province of Terra d'Otranto, which included the modern-day provinces of Lecce, Brindisi and Taranto (Fig. 1).

(<sup>1</sup>)  
The lighthouses are considered part of the industrial heritage in that they are service infrastructures linked to navigation, an indispensable nocturnal signalling system for navigators and a landmark in both maritime and aerial terms.

Over the last few decades, many lighthouses, including the living quarters for the lighthouse operators and surrounding buildings (storage facilities, etc), have been decommissioned and have been completely abandoned.

It was thus considered a good idea for them to be scientifically studied, because this precious legacy linked to the navigation

industry, which until now has received very little attention, needs to be examined closely in order for its full potential to be realised.

This article sets out the preliminary results of the studies of the lighthouses of Punta Palascia near Otranto (Fig. 2) and Sant'Andrea near Gallipoli (Fig. 3).

The second half of the eighteenth century and the whole of the nineteenth century saw an expansion of maritime traffic and consequently, a turning point in the history and technology of lighthouses. We are no longer dealing with a mere beacon, or a column, or a white-painted building, or a tower, but a real lighthouse. New systems of illumination for multiplying the luminosity were invented: the great discovery of gas, especially acetylene, made it possible to have light that shone continuously and above all without supervision. At the end of the nineteenth century the first lighthouses with electric lights appeared on the horizon, but the definitive shift from gas to electricity took place only after the Second World War.

---

<sup>1</sup> The research in progress into maritime industrial archaeology is being conducted as part of the INTERADRIA Project "Eredità culturali dell'Adriatico: conoscenza, tutela e valorizzazione", PIC-Interreg III A Transfrontaliero Adriatico. The project is co-financed by the European Union through the European Regional Development Fund. The lighthouses that form the object of this research are those lying within the province of Brindisi (Secca Riso, Tower Penna, The Pedagne and Forte a Mare), the province of Lecce (San Cataldo near Lecce, Punta Palascia near Otranto, Capo Santa Maria di Leuca and Sant'Andrea near Gallipoli) and the province of Taranto (Capo San Vito and San Paolo). In addition, the ports of Brindisi, Taranto, Gallipoli, Otranto and San Cataldo are being studied. The research is being carried out by Partner italiano 13 PI (Istituto CNR-IBAM, Institute for Archaeological and Monumental Heritage) in Lecce.



Figure 1. Map of the Lighthouses and Beacons on the coast of Italy for the Province of Lecce, April 1885. Corpo Reale del Genio Civile, Classe III, Titolo VI, Opere Marittime -Fari e Fanali, Cartella n° 9, fascicolo 40, anni 1887-1894, "Su concessione del Ministero per i Beni e le Attività Culturali" Archivio di Stato di Lecce. (Riproduzione vietata)

The twentieth century also saw improvements in technology and construction techniques. Lighthouses became automated, controlled by radio, the first signalling systems designed to work in the event of fog were introduced and the architectural design was perfected. If a lighthouse needed to be seen from the maximum distance possible it was necessary to build it as high as possible above sea level.

## 2. THE LIGHTHOUSE OF PUNTA PALASCIA

This lighthouse stands in the exact location where once stood the tower of "Palascia, Pelagia or Palegia", shown on many maps. The tower was demolished in the last quarter of the nineteenth century to make room for the construction of a cottage. A document from 1873 refers to the "[...] Demolition of the old Tower of Palascia located in the point where the cottage will be built, consisting of a block [...] and earth in the shape of a truncated cone with circular bases [...]".

Along the coast near Otranto there were two other towers of similar construction: the tower of the Serpe and the tower of S. Emiliano located to the North and the South respectively.



Figure 2. Lighthouse at Punta Palascia near Otranto



Figure 3. Lighthouse on the island of Sant'Andrea near Gallipoli

It is said that before the lighthouse, the source of light for the Cape of Otranto was the tower of the Serpe, shown in the drawing of the city of Otranto by the abbot Giovan Battista Pacichelli; in his representation of the city, the tower is labelled "Lanternone seu Torre della Serpe".

The Cape of Otranto lighthouse has a "[...] fixed light of the 4<sup>th</sup> order range [...]" and is situated "[...] at longitude 16°, 43', 26" (from the Paris meridian) and latitude 40°, 6', 8" [...]" and illuminates the sea in an arc of 219°.

In a decree of the King's Lieutenant for the southern provinces, dated the 28<sup>th</sup> of February 1861, and in the pronouncements of the Ministry of public works contained in the dispatch of the 4<sup>th</sup> of May 1863, the plan for the construction of the lighthouse was approved. A commission in charge of selecting appropriate sites for lighthouses established, in a statement dated the 7<sup>th</sup> of May 1863 "[...], that this lighthouse must be built on the extreme point of the Cape of Otranto, known as *Punta Palascia*, and precisely on the headland pointing in the direction of the Levant – at the 2<sup>nd</sup> noon from the ruined watchtower; a site lying 30 m above Sea level and 61m below the summit of the cliff, in the area of the watchtower and the port [...]".

The design for the lighthouse was drawn up by engineer Achille Rossi (who also did the drawings for the lighthouse in Capo Santa Maria di Leuca) in November 1863. On the 17<sup>th</sup> of December of that year it was presented to the chief engineer of the Governmental Technical Office of Terra d'Otranto province, Ferdinando Primicerio, who sent it to the Inspector of Ports and lighthouses in Naples for it to be approved by the Ministry.

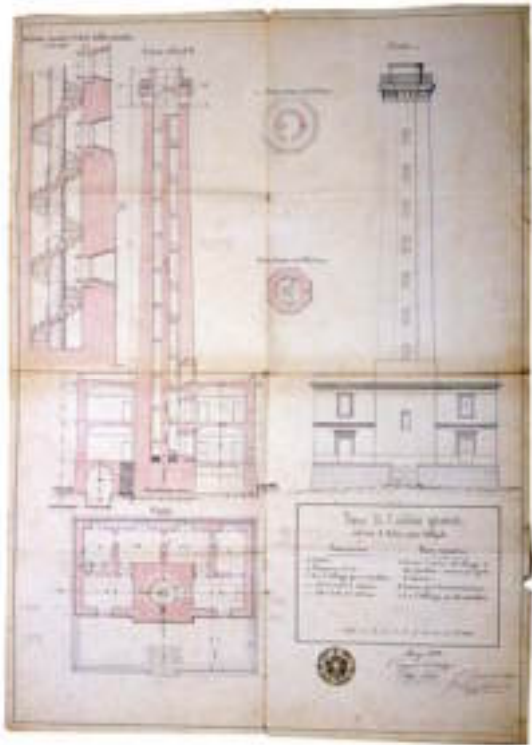


Figure 4. Architect's drawings for the construction of the lighthouse on the island of Sant'Andrea near Gallipoli, 1862. Corpo Reale del Genio Civile, Classe III, Titolo VI, Opere Marittime -Fari e Fanali, Cartella n° 1, fascicolo 1, anni 1862-1865, "Su concessione del Ministero per i Beni e le Attività Culturali" Archivio di Stato di Lecce. (Riproduzione vietata)

Approval for the project was given in the Ministerial Decree of the 24<sup>th</sup> of July 1865. The construction contract was awarded to the Pinto Francesco company, which duly carried out the work, and the building was tested in June 1867. 62,933 *lire* and 29 *centesimi* were spent on the construction of the lighthouse.

The lighthouse is built with blocks of local stone; the blocks that constitute the external wall (which were "conchiferous limestone known as *carparo*") came from the quarries of Santa Cesarea Terme while the blocks of "tufo" limestone used in the building of the vaults were extracted from the quarries of Otranto. For the base, limestone taken from quarries near Otranto, was used. In addition, slate was used to cover the steps of the spiral staircase in the lighthouse tower.

All the walls, both internal and external, were covered in white plaster, which confers an austere character on the construction, standing out against the blue of the sea and the imposing cliff face.

The lens of the lighthouse was supplied and installed by the Barbier et Fenestre company in Paris.

Access to the lighthouse was by "[...] natural paths suitable for passage on foot and horseback, of about 5 kilometres [...]".<sup>(2)</sup>

Today it can be reached by a steep road built during the construction of the lighthouse.

On the 15<sup>th</sup> of July 1867 the lighthouse began functioning and in 1979 it was abandoned.

Conservation work is currently in progress, with a view to the recovery and improvement of the protected area in which Punta Palascia lies.

### 3. THE LIGHTHOUSE ON THE ISLAND OF SANT'ANDREA IN GALLIPOLI

The lighthouse is located on the island of Sant'Andrea which lies about a mile from the ancient city of Gallipoli.

The island on which the lighthouse was built, with a surface of approximately 4.8 ha, takes its name from the small chapel dedicated to the saint which stands there.

Of particularly high value from the environmental and naturalistic point of view, the island is an EU Site of Community Interest (SCI) and a Special Protection Area (SPA). The project (Fig. 4) for the construction of the lighthouse, which was to have "[...] a rotating light of the 3<sup>rd</sup> order range [...]", was drawn up by the chief engineer Ferdinando Primicerio and 3<sup>rd</sup> class engineer Filippo Pinto on the 24<sup>th</sup> of October 1862; the work, entrusted to the Francesco Pinto building contractor in November 1863, began in March 1864 and was completed in the month of September 1865. The side of the island chosen for the construction was the one "[...] which looks on to the Gulf of Taranto [...]".

The lighthouse (the tower, the base and the living quarters for the lighthouse operators) was built with blocks of local conchiferous limestone ("*carparo*") from "[...] quarries on the island [...]"; the stone used for work such as: the steps of the spiral staircase and the steps up to the entrance to the living quarters, the upper cornices of the tower, the base, and other details was extracted from Monte Santa Costantina near Casarano, a town in the Salento peninsular about 30 kilometres from Gallipoli.

On the 13<sup>th</sup> of July 1875 a project for the construction of new living quarters for the lighthouse operators, the completion of the two access roads and the two landing stages on the Levant and Scirocco sides was presented.

The first project for the vegetable oil lamps supplied by Henri Lepaute of Paris dates back to 1866; the same French company supplied the new lamps, fuelled by petroleum, in 1889.<sup>(3)</sup> The latter were used up to 1947, when the system changed over to electricity.

Until 1974, when the lighthouse operators left the island for good, the lighthouse had a constant rotating light; subsequently it became a simple flashing light.

### 4. THE RECOVERY AND COMMUNICATION PROJECT

#### 4.1 General aims

The main objective of the project is the development of **low-cost** methodologies and techniques to form the theoretical and experimental basis for the acquisition of greater specific knowledge, with a view to enabling these important exemplars of our industrial heritage to be appreciated and enjoyed by the public.

These methodologies and techniques are based on the use of processing systems which make images a real instrument of knowledge. These images are not just observable, but will

<sup>2</sup> Archivio di Stato di Lecce, Corpo Reale del Genio Civile, Classe III, Titolo VI, Opere Marittime -Fari e Fanali, Cartella n° 1, fascicolo 6, anni 1863-1867

<sup>3</sup> Archivio di Stato di Lecce, Corpo Reale del Genio Civile, Classe III, Titolo VI, Opere Marittime -Fari e Fanali, Cartella n° 1, fascicolo 1, anni 1862-1865; Cartella n° 3, fascicolo 14, anni 1875-1876; Cartella n° 6, fascicolo 26, anni 1889-1890

provide the basis for the creation of three-dimensional digital models embedded in communication platforms based on 3D metaphors. The research carried out has produced forms of information which are heterogeneous in terms of their content and representation techniques. In some cases, the results of the research concern the architectural structures of the historic building directly; in other cases they use the building as a jumping-off point for further scientific and practical enquiries of a more general character, in the field of multimedia communication. Starting from these assumptions the intention was to create a multimedia platform, developed in the *Shockwave* environment, characterized by an interface providing access to the information that was able to meet the following requirements:

1. Make available methodologies based on web techniques for the navigation of knowledge;
2. Collocate the knowledge acquired of the historic building in an environmental context, highlighting the possible relationship between the building and the surrounding area;
3. Integrate the 3D models of the historic buildings into three-dimensional digital models of the terrain, correlating the historic and documentary information.



Figure 5. User Interface of DVR platform

## 5. LOW-COST TECHNIQUES AND SPECIAL PROPERTIES OF PHOTO-MODELLING

Starting from this premise, in the initial phases the work addressed itself to the acquisition of basic photographic documentation and the search for techniques that were suitable for creating a restitution of the lighthouses at a high level of detail and precision. Considering the aims of the communication project (and the products that will result from it) and the specific surveying problems, these basic requirements were met by restitution techniques based on digital photogrammetry, particularly photo-modelling.

The reasons for this choice lie in its greater flexibility and ease of use with respect to normal photogrammetric techniques, but above all in the possibility it offers of obtaining three-dimensional models of great precision at a reasonable cost. In this specific case, it is important to stress that the surveying difficulties resulting from the great overall height of the buildings (about 30-40 metres), together with the problems of accessibility, mean that traditional photogrammetric surveying techniques would almost certainly have entailed considerable effort, as well as additional costs in terms of the equipment required. Furthermore, the aims and premise of the project ruled

out the adoption of any system based on laser scanning. There are two main motives for this: the first is the currently high cost of long-range laser scanners, the second lies in the excessive number of polygons produced automatically by a normal scan, clearly superfluous for the description of the regular polygonal surfaces that characterise the external geometry of the architecture under study here. In contrast, in architectural surveys conducted with a specific purpose, a fundamental role is played by the person conducting the survey, who must identify, by means of a careful analysis of the architectural features, only the main points necessary for the restitution.

The task of identifying and matching corresponding points on the structure appearing in photographs taken from different angles is also a fundamental part of surveying with photo-modelling. In operational terms it is sufficient to identify the vertex of each architectural detail, or insert some targets into the poorly characterized areas of the facade, in order to obtain complete three-dimensional models of the textures mapped in UVW projection. The complete survey of the lighthouse of Punta Palascia near Otranto entailed the use of about twenty oriented photos and the intervention of a mid-level surveyor for about 10 days. The use of commercial software and a simple digital camera for the production of the basic medium (digital photography), necessary for the creation of the various contributions (3D models, QTVR), also represents a useful methodology in small to medium-sized operational situations.



Figure 6. Three-dimensional model of the entire Salento peninsular, on a scale of 1:25,000, mapped with a satellite ortho-photo, which the visitor can explore freely in RealTime 3D

## 6. EXPLORATION OF THE 3D MODELS AND COMMUNICATION STRATEGIES

Apart from the ease of use and the considerable results that any reasonably skilled operator will obtain in a survey based on photo-modelling, this technique makes it possible, as mentioned above, to obtain three-dimensional models with a low number of polygons with their associated textures. This feature is highly significant, if one considers the use of these models as an operational basis for the development of communication products based on 3D metaphors. Every desktop solution requires models with the lowest possible number of polygons, in order to ensure the greatest ease of management, especially on entry-level hardware, and this is even truer of web-based applications.

In this study the three-dimensional survey was embedded in a communication platform based on *Shockwave* technology, in which the end user can develop an integrated cognitive pathway



Figure 7. Virtual visit of Salento coast into Realtime 3D platform

for an item of cultural interest, which starts with the architectural characteristics and proceeds to the description of its possible relations with the surrounding area and community. Thus a file was generated from every 3D model with rendering in *Radiosity* in the *QTVR Object* format, known for being one of the most user-friendly available today. This format has the particular merit of combining well with other virtual panoramas photographed directly *in situ* and being easy to transform into a container of multi-dimensional hyper-links.



Figure 8-9. 3D models of Otranto Lighthouse

In a single virtual scene, visitor itineraries can be activated in which virtual and real items combine, having both been created from a shared basis, i.e. digital photography. We argue that this approach, closely tied to the architectural documentation of the monuments as they appear in real life, is fundamental to the

provision of distance visiting based on information technologies. From the end user's point of view, the visit to the lighthouses can be activated not only from accessible observation points, but also, and above all, in ways that would be impossible in real life. In any case, all the elements in the scene, both those in 3D and those in QTVR real panos, faithfully represent the actual state of the heritage item.

The virtual visit is not limited however to mere aesthetic viewing of the architectural aspects of the monuments. The virtual platform also aims to inform the visitor about all the historic and environmental aspects that characterize the item. Given the heterogeneous nature of the data, which are both gathered from other sources and generated ad hoc, they can be enjoyed in various ways depending on the specific medium; they are intended for professional scientists and the general public alike. As well as the 3D models, the original architectural drawings, the plans of the surrounding area of each lighthouse, the original functions of the rooms and the technological apparatus necessary for their functioning can be consulted. It will be possible furthermore, to show the relationships between the lighthouses and the historic legacy of the region, but above all to fly over the ports and stretches of coast that are situated near them. Since the beams from the lighthouses cover the entire coast of the Salento peninsular, the virtual itinerary of what the visitor can admire from the air goes from S. Cataldo all the way to Gallipoli. To this end, a three-dimensional model of the entire Salento peninsular, on a scale of 1:25,000, mapped with a satellite ortho-photo, which the visitor can explore freely in RealTime 3D has been proposed. Using the same model the visitor can observe aerial photos of the coast or activate alternative historic and cultural itineraries, but the important thing is that he/she will be able to see the actual range of the lighthouses and the location in the territory.

## 7. CONCLUSIONS

At the time of writing, photo-modelling has been completed only for two of the four lighthouses under study here.

However, the work carried out to date has made it possible to determine the level of reliability and the actual operational productivity of the techniques being applied.

The architectural survey will shortly be followed by a systematic analysis of the state of conservation and a mapping of the main forms of decay of the construction materials.

The communication platform will be aimed at a wide and heterogeneous public. The choice of technologies used makes it possible to activate itineraries that are differentiated according to the themes tackled and the level of detail. Exploration in RealTime 3D may alone represent a useful instrument for learning about the morphological characteristics of the Salento, but above all it is a valid means for promoting the cultural resources of the Salento for the purposes of tourism.

The choice of technologies, all based on commercial software, is motivated by the desire to draw the attention of professionals from the world of research and from organisations responsible for the protection of historical resources to the possibilities provided by low-cost ICT applications in the conservation and recovery of cultural heritage; rather than mere instruments, such applications should be seen as part of an integrated approach.

**ACKNOWLEDGEMENTS**

Our special thanks to Arch. Kutlutan Fisekci (Master SIDART, Università di Lecce, Italy) for his important contribution in the photo-modelling process.

Dr. Giuseppe Brambilla (Master TEC-CH, Lugano University, Switzerland) for his support activity.

Ing. Cesare Cazzato and his aerial photos.

E. Simonetti, *Lampi e splendori. Andar per fari lungo le coste del sud*, Roma-Bari, Gius. Laterza & Figli, 2000

P. Lévy, *Il Virtuale*, Raffaello Cortina Editore, Milano 1997

A.A.V.V., *Bollettino ICR* Luglio-Dicembre 2002 nuova serie N.5, Nardini Editore, Firenze 2004

M. Rossi, P. Salonia, *Comunicazione multimediale per i beni culturali*, Addison Wesley, Milano 2003

**REFERENCES:**

Voce FARI, Enciclopedia delle Arti e Industrie, Volume Terzo, Torino, Unione Tipografico-Editrice, 1882, pp.346-370;

P. Leonardi Cattolica-A.Luria, *Fari e segnali marittimi*, Torino, Stab. Doyen di D. Simondetti, 1916

E. Almqvist-G. Cederberg-E. Hillberg-D. Thunman, *Lighthouses of the world. A history of where land meets sea*, Svezia, de Nordbok, 1999;