6 DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN
XV to XVIII Centuries

Ángel Benigno GONZÁLEZ AVILÉS (Ed.)

DEFENSIVE ARCHITECTURE OF THE MEDITERRANEAN

XV TO XVIII CENTURIES

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Ángel Benigno González Avilés

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The Fortress of Giove (or Giogo) on the Elba Island: 3D survey for knowledge and dissemination

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Abstract

The topic presented in this paper is part of a wider research network about the Elban fortification system that last year has produced two works discussed during the Italian edition of the FortMED 2016.
The research proposed this year has the will to give the actual state of remains of the Fortress of Giove near *Rio nell'Elba* (*Livorno*, Italy).
The fortress was built in 1459 from the Appiani family, at that time authority of the Elba Island. Initially it was rectangular shaped with a scarped wall and a dry moat all around its perimeter and a fortified tower with the entrance on the North façade. The fortress was destroyed first by the Ottoman pirate Dragut in 1533 and decisively from the Spanish governor of *Porto Azzurro*, Mouroy de Pinel.
The aim of the digital survey, operated with a 3D Laser Scanner and a professional photographic equipment, is to have a complete coverage of the entire structure, without forgiving the masonry texture, useful to bring hypothesis about its original shape and eventual architectural changes.
Also this study will contributed to complete the panoramic view of the Elban fortifications started in 2016 for initiative of the Architecture Department of the Florence University.

Keywords: Fortification System, Elba, Fortress of Giove, digital survey.

1. Introduction

History of Elba is a history of mines and iron veins: over the centuries controlling this island has always meant economic and geographic power. For this reason all the populations that have made Elba as their home, has always provided to build, reinforce or re-design a proper fortification system.

However the fortification systems, both on the coast and on the inland, ended their function with the end of the piracy. Starting from this period and until the re-discovery of the importance of the historical value of this strong and enormous ancient buildings, the fortresses and the coastal towers has been totally abandoned. When the interest on the ancient building and their conservation methods re-grown (after the second half of XVIII century), many of these fortresses, both in Elba but also in the whole Mediterranean territory, has became a ruin. So the loss of their function and the economic difficulties necessary for their restoration, caused a further post-position of structural restoration interventions.

With the renovated interest of the last years and the interesting points of discussion proposed by this conference, the DIDA (Department of Architecture) of the University of Florence, has started a survey-for-knowledge program to obtain the actual state of remains of the most important fortification of the Elba Island. The

first results of this research have produced the survey, the reconstruction hypothesis and in some case also tangible 3D models, helpful to study this interesting fortification system[1].

1.1. Some notes on the work-program

During the last year survey campaign, a first, precedent, site inspection has highlighted the most important points to be studied, enumerating: the Volterraio Castle, the Tower of St. Giovanni, the Appiani Towers in *Rio Marina* and in *Marciana Marina*, the Fortress of Giove (Fig. 1). Due to the limited time for the campaign, the first two study objects were been the Volterraio Castle and the Tower of St. Giovanni in *Campo nell'Elba*.

Fig. 1- Fortress of Giove (A. Mancuso, 2017)

However during the survey-campaign days a site inspection on the Fortress of Giove has turned out to be a building as interesting as vast (in terms of square meters and difficulties of data gathering for the presence of tall and disseminated vegetation) to deserve a peculiar study, that could provide the current state of the ruins. For this initial impression the survey of the Giove Fortress had been postponed to the subsequent year, and in April 2017 the works on it started with a better fixed timing and proper instruments to make the work more feasible.

2. Historical Notes - The Fortress of Giove

Elba was inhabited since a very long times: Paleolithic and Neolithic populations, Mycenaean, Etruscan sat there one on their most important reference point[2].

Fig. 2- Elba, Historical Cadaster of 1882 (Regione Toscana - Geoscopio - Castore)

The Fortress of Giove is located on the North-East part of the island, not far from the ancient town of *Rio nell'Elba* and from *Rio Marina*, a little, young town famous for its iron mine: in fact this area has been exploited since the Etruscan times for mining purposes.

The mining activity in the island has been more or less flourishing. However, in the past, it has never been completely abandoned and who directed it had the duty to safeguard the territory from attempts to conquer. It was therefore necessary to build points of observation and communication. The Rio area in Elba was away from the pre-existing fortress of Volterraio and so in the XV century the Appiano family started to build a defensive structure to strengthen and secure its own domination of the island. The area chosen for this new fortification had been the peak of the Mount Giove, which it took the name. It was in visual communication with the Volterraio Castle and had a clear view on the *Piombino* Strait, the *Rio Marina* coast until the Tuscan coast. The fortress was also supposed to serve as a haven for the inhabitants of *Grassera*, a village next to the castle no longer existing. However, it does not always succeeded in the role of sentinel against the dangers of the pirates: in fact it first undergone to an attack by Barbarossa in 1534 and then, in 1553, to a big battle against Dragut, event that made important damages to its structure[3].

During the 1600s with Spanish domination, the fort was guarded by Iberian soldiers and was not immune to attacks. However, the decisive destruction of the fortress took place in 1708 by order of Spanish captain Pinel de Moroy: at the end of the Austrian attack on *Porto Longone* (today *Porto Azzurro*), he thought that the islanders could cope with the enemy. So he decided in retaliation to dismantle many of his defensive works, including the Fort Giove[4].

However the bibliography is not so rich, and an archaeological search (already hoped in the archeologist Marta Ricci's degree thesis), would be necessary to establish, more precisely, the stratigraphies and events that made its history.

3. The Fort Giove now and the survey campaign

Due to the destruction of 1708 and of the subsequent four centuries of abandonment, this structure today is heavily ruined and manifests a need to secure collapsing parts. But only a restoration intervention can put an end to the increasingly invasive vegetation on all façades and can restitute the ancient majesty to the impressive fortress.

3.1. The digital survey campaign - April 2017

Once Giove's fortress was reached, with a 20-minute walk in the forest surrounding it, we spent some time to plan the different procedures. With the observation of the fort and its surroundings, it was possible to identify and locate the most important portions of the site and those with significant emergencies that need greater attention.

As previously mentioned the most important component observed at this stage was the presence of invasive and historically rooted vegetation. In fact, while admitting the abandonment of the ruin after the destruction of 1708, the lack of interest of the community and administrations has come to light, which has led to the natural uncontrolled growth of plantations, invading the spaces of the object that are usually free (such as the patrol path) or rooted in wall portions completely concealing their visibility.

At the same time were observed the areas where some parts of the fort have ruined and the formation on them of routes of fruition different from the originals. This observation is proposed to underline the need to evaluate any visual occlusion that these debris could have caused, but also the possibility of using them to reach stations useful for saturation on unobservable work portions. When this inspection phase is completed, work has been carried out with site preparation: the cleaning out of highly infested or invasive vegetation and the application of useful targets for the follow-up procedures to register the data[5]. Site preparation operations have led to the removal of many bushes and weeds, bringing to light the components of the essential system to its understanding, and to cut down some young plants that could have affected survey operations, this using non-invasive grinding techniques, both for the natural environment and for the future layout of the building and its surroundings (Fig. 3).

Fig. 3- Fortress of Giove - East Façade: the invasive presence of vegetation (G. Verdiani, 2017)

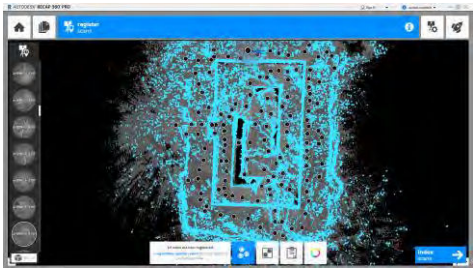

Fig. 4- Fortress of Giove - The pointcloud with the station points (G. Verdiani, 2017)

Fig. 5- Fortress of Giove - The pointcloud view in Autodesk Recap (G. Verdiani, 2017)

Subsequently the work went on with the two important survey operations. The first was the indirect digital survey with phase shift 3D laser scanner: a Zoller+Fröhlich Imager 5006h, with a secondary battery to facilitate the full-day operations. The site has been run 140 stations, useful to cover the entire surface of the building and its parts. The numerical data, however, does not make the idea of the changeable course of the shooting points: the scans were not evenly distributed but with a clot in the more occluded portions (due to the vegetation or morphology) and with a drift in the free and open portions (Fig. 4). The instrument settings also vary depending on the pick point, going to produce more detailed scans on strategic points, and speeding up scanning operations through a smaller detail request in passages that are only useful to linking particular portions of the fort.

The second and last significant phase was the photographic documentation, consisting of two types of shooting: a free, symbiotic and functional search for clarity the Fortress of Giove and the historical events on it readable; the second one aimed at the digital photogrammetry. This second phase will be dealt with in a dedicated chapter, but it has to be said that it has been chosen to focus this type of survey on only the interior masonry of the fort. This for two reasons: the impossibility of covering the outside uniformly and completely; the willingness to deepen the documentation on the few remains of the interiors in order to be able to record useful knowledge of the original layout and constructive strategies adopted.

4. The data processing

4.1. Processing the pointclouds

After *in situ* operations, the work continued with the restitution of the collected data. Initially pointclouds were registered. This was done quickly, using the Autodesk Recap software. The software stands out positively for several features. The first is the possibility of using the data in native format of the scan tool (.zfs), eliminating the dead times of the filtering.

When loaded single scans, it starts recording, so the second positive feature: the application allows automated logging of different files, through internal analysis and recognition procedures, based on the morphology of individual clouds. This operation is largely long but leaves time for observation, early analysis and control over the calculation result. In fact, the software interface is not hindered by dialogue boxe, but allows input and navigation in a 3D environment that contains the point cloud in processing and observing the "live" addition of individual pointclouds. After the registration operation was completed, three different macro-clouds were created. These were combined in the total one by means of the manual alignment tool, identifying by the operator as three common points on each partition cloud, the software assembled the subgroups, thus obtaining the final result, a cloud described by 654 million points. Rapid control and sporadic observations of the scenario have always been carried out on this software platform; this is a great way to navigate 3D so complex in 3D environment, a further cue for using Autodesk Recap (Fig. 5).

The last step was the export of the cloud in .pts format, designed for migration to apposite environment to build the mesh.

4.2. Building the mesh

The global pointcloud was imported in 3D System Geomagic, a pointclouds and mesh management software allowing both a reordering and a data clean-up. In this virtual environment, a first mild decimation was carried out, allowing the import and use of the cloud.

Next, the work proceeded launching the mesh construction tool, calculating the polygons on the points of the cloud, obtaining a main mesh of 10 million polygons. A cleaning was carried out on this, aimed to lighten the model and eliminate the vegetation. Through various and repeated processes of selection, elimination and reconstruction, alternating with automated analysis and control tools, has come to a stable and manageable three-dimensional model. The mesh in question, consisting of 4 million polygon, was then exported in .obj Wavefront format and imported into Maxon cinema 4D a modelling and rendering software. In this environment it has been shaped forms corresponding to real data in order to propose a re-constructive hypothesis of the original morphology of the fort.

4.3. Texturing the interior front: an application of digital photogrammetry

At the same time as the operations described above, the calculation of the 3D model on a photographic basis was performed, carried out with Agisoft Photoscan, a software dedicated to photo-based reconstruction.

Photographic surveying operations, as mentioned above, were performed by framing the visible inner wall portions of the fort (Fig. 6); this to focus attention on the large number of visible traces and emergencies on the wall surface. These tracks allow the reading of the internal organization, now completely lost, and can help to speculate on the original layout of the space distribution. It is also possible to rely on existing examples and to confirm the type of project with similar analogues.

Fig. 6- Fortress of Giove - The interior façade, with the remains of the vaulted ceiling (A. Mancuso 2017)

The survey was carried out with professional equipment and about 350 photographs were taken according to the principles of organization of the photogrammetric survey[6]. The resulting work in the studio involved their processing, through the canonical software itinerary[7]. The final result was exported in Waveront .obj format with attached .mtl. The work path was completed similarly to the 3D laser scanner data on Maxon Cinema 4D software, where the ability to calculate render images was chosen in order to make the most useful and attractive restitution of the obtained results.

5. Reading the Fortress of Giove: structure and reconstruction hypothesis

Before going to the reconstruction, it is necessary to describe the fortress by summarizing *in situ* observations, the reading of the survey data, and a reasoning about all the components now known.

The Fort Giove was a defensive system consisting of two components: the base with an access by a drawbridge and the tower built on three levels. The general layout is rectangular, developed with the short side aligned to the North-South and the long-aligned East-West. The base consists of: a scarp-wall with a height of about 5.00 mt and an inclination of about 13.5 degrees, a vertical portion that overlaps it with Guelphscrenelation, with medial embrasures 2.00 mt high in the highest point and 1.10 mt high in the lowest point. The access point is made up of a single opening with a drawbridge (underlined by a semi-arch external structure)

positioned approximately at the midpoint of the south side and advanced compared to the outer edge of the building. The drawbridge is a well-preserved and readable part (associated with this, the presence of the moat on the three sides of the fortress is emphasized. The west side is excluded because it is geo-morphologically characterized by a natural scarp. This is also observed by a map dating back to 1882). Finally, a patrol path occupies the entire perimeter providing a distributive ring of about 3.30 mt.

The tower is more complicated to read, having to refer only to two incomplete mural portions and with just a reference of the vault imposts. Overall it is about 16.00 mt high (from the level of the patrol path) and divides in the scarp-wall high 3.60 mt, with inclination of about 16 degrees and in the main body 12.4 m high. Inside there are three levels occupied by barrel-shaped rooms with varying heights; the wall curtain has a thickness of about 0,85 mt and is sack type. For defensive purposes, access to the environments was from the East side, so it was not in line with access to the base. However, this is not evident. The only trace is the identification of a small access to the lower environment, occupying the portion of the tower scarp, and of a more important access to the overhead plane. This leads us to conclude that these two environments were not internally connected and that the lower level was used as a deposit.

It is not possible to hypothesize on the connection between the first and the last level. It is also difficult to imagine the internal division of environments: reading a wall stall leave open the hypothesis of an internal partition, but no reliable traces can be found. Likewise, it is not possible to understand the organization of the terrace; the arrangement of the stones may indicate the presence of a crenelation or embrasures, but both the extent of this portion and the dimensional relationships between the parts, do not allow them to recognize the a certain presence. In addition, the presence of a series of openings on the south side (almost completely in line with the entry of the drawbridge) makes it think of a goods-lift column, but it is not possible to give a right interpretation.

5.1. Digital Reconstruction Hypothesis

The concluding part of the work was the digital reconstruction of the the fortress. This operation was performed using Maxon cinema 4D because of the flexibility of navigation on the mesh, calculated on the laser scanner pointcloud, and the versatility of addition simple solids describing the final shape (Fig. 7, 8). The reconstruction hypothesis was not generated from scratch, but with the support of the actual state, providing strong justifications for the composition of new volumes and creating a scientifically correct set. It is possible to note that no additions or subtractions of form have been hypothesized that were not suggested by the data of the survey. Therefore, even though the distribution of openings could be intuited, these were not recreated where their presence was not readable. An analogous position was maintained in the mesh reordering phase: no wall patterns were created where they were not readable due to a vegetation removal. This to avoid suppositions based on un-objective data. For the crenelation, which is always repeated in the same way, the deficiencies have been filled. The entrance door on the East side of the tower, has been positioned thanks to the left jamb, identifiable by the position of the stone blocks, typical of the angles, associated with the presence of the hinge housing and the threshold cut. The reading of the cut of two stone blocks allowed to locate the shoulder of the bow and provided discrete information on the curvature, good to determine the extent of the opening. Moreover a part of the entrance system, constituted by stone retaining walls forming a sort of staircase, has been revealed just in the shape obtained from the survey, as it has been impossible to find a correct lecture of its function and configuration. The internal staircase system is not readable at all, so it was impossible to make any building hypothesis: whether in the case it was a system of wooden staircase or a stone structural staircase, the only plausible hypothesis is about its location in the area most affected by the collapse. As a matter of fact, a controlled demolition will surely have hit the most sensitive parts to make the fort useless as an observation point for its territory.

During this phase, it was possible to make an important observation on the fort Giove's ruins: the entire building is instable. In fact, from 3D observations with orthogonal view, a multiple layoff of the building was observed, due to the loss of horizontality by the planes (for example the patrol path) and the inclination of the stone blocks planes constituting the fort's wall. This instability, perhaps due to hydro geological causes, is producing a ditching of the basement on the northeast side. It is also possible to it on the crenelation of the south side.

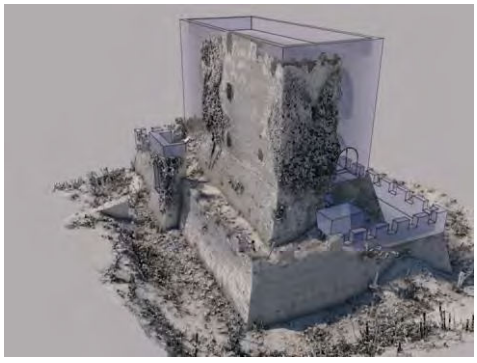

Fig. 7- Overlapping of the remains and the reconstruction hypothesis (A. Pasquali, 2017)

Fig. 8- Overlapping of the remains and the reconstruction hypothesis (A. Pasquali, 2017)

The central body is under the same slip on the south-east corner; this for various causes: too much weight on the supporting ground (it is the only and last corner of the tower still existing) or a structural failure of the undercut chamber of the fort (of which one can perceive only a small part of the vault). This phenomenon, however, refers to a prolonged action over time, because no timely or circumscribed changes with structural emergencies are read, so it is possible to rule out sudden instability phenomena that can be attributed to past or future collapses.

6. Conclusion

The search path ends with two main results. The first is related to the survey experience and the reading of the data obtained, that is, the knowledge of our study-object, the possibility of creating useful and fundamental assumptions for hypotheses arising during the approach to the site and the first observations of the Fort Giove. The second output of the research is directed towards the outside, to the scientific world directly or indirectly related to this theme and to the formation of a general knowledge that can be summed up with the existing knowledge on the fort and on the defense network that hosted it.

This work has provided archival documentation the first true and complete digital survey of the site, recording the state of the art related to dimensional and morphological characteristics and the state of degradation, with peculiarities on the structural situation. To this is linked a reconstructive hypothesis, incomplete but based on rigidity and scientific attention, that can create a useful component for future observations, for ordering and clarifying some erroneous information and interpretations found, and this without avoiding criticism, whether our interpretation is contestable on other observations or newer similar experiences.

To conclude, there is a willingness to put this survey in contact with other analogues by type or period, in order to continue to provide clearness on the true configuration and the function of Fort Giove. This is possible using digital techniques in order to broaden the readings obtained and to create new methodologies for analysis on complex and often antiquated apparatus without the necessary attention, that, in some cases, were not considered as fundamental elements for the understanding and preservation of the history of architecture and its products.

Notes

[1] For these works: Mancuso A., Pasquali A. (2016); Baldi G., Pucci M. (2016); Baldi G., Pucci M. (2017).

[2] For a compete historical frame check Foresi E., Foresi S., Lambardi S., Ninci G., Pintor F., Vanagolli G., Zecchini M. and the Degree Thesis by Ricci M.

[3, 4] Check the "Storia dell'Isola d'Elba" written by Ninci in 1815 and edited in 1988.

[5] As we will observe later, the treatment of individual scans is driven to automated procedures and their potential, tu us is known and experienced. As a result, targets were placed in the portions of the building where digital registration automation was unsafe.

[6,7] For a wider frame on phtogrammetric processes, see Mancuso A., Pasquali A. (2015), Guidi, G., Gonizzi, S. (2014) and Verdiani G. (ed), (2011).

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