DIGITAL RECONSTRUCTION AND ANALYSIS OF TURCHINIO'S TRABOCCO

A method of digital reconstruction of a complex structure as a way to improve our knowledge of a cultural heritage artifact

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Abstract. The aim of the following paper is to show a method of digital reconstruction and analysis of an important artifact pertaining to the Abruzzo cultural heritage, the 'trabocco'. In fact recent software for graphics and architecture, such as CAD, graphics editor, and those dedicated to three-dimensional modeling and rendering are tools that open new opportunities in the study of cultural heritage artifacts, The more the complexity of the object to study, the more the advantages for their use. A formal and structural complexity characterize the trabocchi, pile constructions typical of the Abruzzo coast, that go back to the middle of XVII century and the subject of this study is the trabocco of Punta Turchinio, the most famous and complex of the coast. Among the digital reconstruction's objectives there are: Increase the knowledge of the 'trabocco' and generate a series of information necessary to define and manage a recovery plan; to study more deeply the technologic decomposition of the four main sub-systems with related abacus of the technological elements and create static and animated graphics restitutions such as renderings and animations to understand some spatial and formal characteristics.

1. Introduction

In recent years, the use of softwares for graphic and architecture is looking for new application fields, besides the architectural design. They are also dedicated to the study of hand-manufactures pertaining to the cultural heritage. Although the greatest part of these instruments creates information

and reconstructions in a virtual environment, paradoxically, this "virtual" is useful to improve and increase the knowledge of the "real". In fact, it opens new scenarios to the comprehension of the constructions pertaining to the ancient cultural traditions, because it gives the possibility to study, analyze and obtain data so far unthinkable with traditional means. Furthermore, the higher the formal and structural complexity of the hand-manufactures to study, the higher the benefits linked to the use of these innovative technologies will be. This statement has been proven during the experience of the digital reconstruction of a "trabocco".

2. The subject of the Digital Reconstruction: the "Trabocco"

The "trabocchi" are pile-dwelling constructions, particularly suitable to environmental situations, such as marshy lands and subject to flood or lake shores, located along Abruzzo's coast (a region in the centre of Italy, on the Adriatic Coast). These hand-manufactures date back probably to the XVII century when some familiar groups coming from the Centre-North of Europe (in particular Germany and France) settled in the area between San Vito Chietino and Rocca San Giovanni, locality near the coasts devastated several years before by the earthquakes and seaquakes (Cupido, 2003).
Through the wits and the handicraft knowledge, these foreign families overcame their seafaring lacks (as they were not able to swim or built a boat), build a system that could permit them to fish on the seashore (at that time fishing was the only sustenance resource), even when, due to the rough or non-limpid sea, it was not possible to use harpoons and fishing spears (Forlani, 2005).

In past times along the Abruzzo coast there were about 50 "trabocchi" (Forlani, 2005), unfortunately nowadays more than half remained and have been preserved in different ways. All the "trabocchi" on the coast belong by now to private owners, except one, the "trabocco of Punta Turchinio" (so called because of the place where it is located), owned by a public entity, and maintained by San Vito Chetino Council.

The "trabocco del Turchinio" (Figure 1) is the most famous on the entire coast of the Abruzzo region, in fact it has been described, in a very suggestive way, by the well-known writer and poet Gabriele D'Annunzio, in his famous novel "The triumph of the death", who compares it to a massive spider. The image evoked by the writer is really effective and provides a fantastic interpretation of the hand-manufacture, that could easily recall to the mind the extraordinary machines by Leonardo Da Vinci.

Figure 1. The Trabocco of Punta Turchinio

3. Definition of the Purposes of the Study

This study is part of a university research, which has the aim to elaborate a guide for the maintenance of the 'trabocchi' located in the Teatina coast (Commissioner: Province of Chieti; Scientific Responsible: Professor M.C.Forlani, DiTAC). To create a recovery plan we need to increase the knowledge of the 'trabocco' and have more detailed information. In fact, until today, the material we have is limited to historical, iconographic and censorial information, useful to diffuse some simple images of historical-tourist meaning. The only available drawings are either too schematic or free interpretations of the real constructions, ineffective materials to undertake actions for its recovery and maintenance. The 'trabocco' is a quite complex structure and impossible to understand the relationship and the positions of all the elements by traditional sketches and drawings.

The objectives have been the following: to increase and enlarge the knowledge of the 'trabocco' and generate a series of information necessary to define and manage a recovery plan and configure a maintenance booklet in respect to the strict laws in force. The realization of a three-dimensional model has permitted, through perspective and axonometric views, to study more deeply the technological decomposition of the four main sub-systems: the footbridge, the stabilizing reticulum, the fishing floor level and the fishing apparatus, with related abacus of the technological elements.

Static and animated graphic restitution like renderings and animations have permitted to understand some space and formal characteristics, as well as permitting the fruition of this fascinating construction by a wider audience, such as those who did not have opportunity to visit the "trabocchi" yet. A complete three-dimensional model has been provided to the structural

engineers, without which it would have been impossible to make structural analysis. The same 3D model is shared with other experts, and consequently increases the precision and the connection among the achieved results.

4. The Main Phases of the Digital Reconstruction

Once all the objectives have been defined, the digital reconstruction work started and was divided into four main phases, starting from the study of the hand-manufacture from life, until arriving at the final three-dimensional animations. The realization of the three-dimensional model has been the core role of the whole work, because in presence of this out of ordinary construction, it has been impossible to proceed with the usual succession in the creation of the work or to apply most of the techniques that are commonly used to represent, for instance, a common building or a house.

4.1. THE SURVEY PHASE

It is easy to realize that the first phase, the survey, although presenting several analogies with the classic survey method, it is however different. In fact from the metric point of view, it has been possible to find only determinate measures, due both to the totally irregular nature of the construction and to it being located in water. For instance I have not had the opportunity to use an instrument like a 3D laser scanner because of the absence of a steady plan area. Using a measuring tape, the elements were measured and lengths of the footbridge and the fishing floor, and, with a plumb-line, the height of the trample level from the surface of the water of every reachable pile. In fact the footbridge has an irregular trend in plan mainly due to the shape and height that differs from each pile.

The hand-made sketches served as basis to report all the measured data, to take notes on the unobtainable elements and to mark the position of every single picture taken with a 5 megapixel digital camera. I have taken the pictures in every possible position, even from a small boat, to document the inaccessible points, thereby impossible to draw, first of all the beams tangle of the fishing floor level (Figure 2).

Figure 2. Picture taken from a small boat

4.2. THE DEFINITION OF A METHOD

After all the basic information has been acquired, A method useful to achieve the objectives described previously was chosen. Until now, as far as I know a three-dimensional model of the 'trabocco' was not previously realized. New challenges were faced in constructing the model due to the lack of a reference model. Every experimental three-dimensional execution has its own story, and the methods depend on the knowledge and experience level, besides the available technical instrument.

I have used the followings computers: for the first part of the work a laptop with an Athlon 64 3200+ processor, 512 Mb RAM memory and a graphic card ATI Radeon 9700 with 128 Mb memory, and afterwards a desktop computer with an Athlon X2 3800+ (dual core) with a 1Gb RAM memory and a graphic card nVidia GeForce 6600 by 128 Mb. The software packages used have been the following: Photoshop, Gimp, Illustrator, AutoCAD and 3D Studio Max.

It was difficult to draw elevations, due to lack of available measurements of the existing structure. I have chosen an experimental approach that, from the realization of the three-dimensional model, appropriately synthesized in less important parts, would permit obtaining all the other required information.

Moreover, the computers used, the high number of elements that make up the 'trabocco', the final purposes together with the personal knowledge obtained in the videogames field as level designer led me towards the realization of a low-polygon number model, easier to manage and modify.

4.3. THE THREE-DIMENSIONAL MODELING

The 3D modeling has been directly designed in 3D Studio Max, therefore with a pure modeler and without CAD which is more oriented to the precise geometric design and consequently even more complicated, if we had to act with small and frequent touches, as it has been necessary in this case. In order to start building the subject model, it has been fundamental to design a plan in AutoCAD, useful as dimensioned reference and import it in the 3D Studio Max working environment (Figure 3).

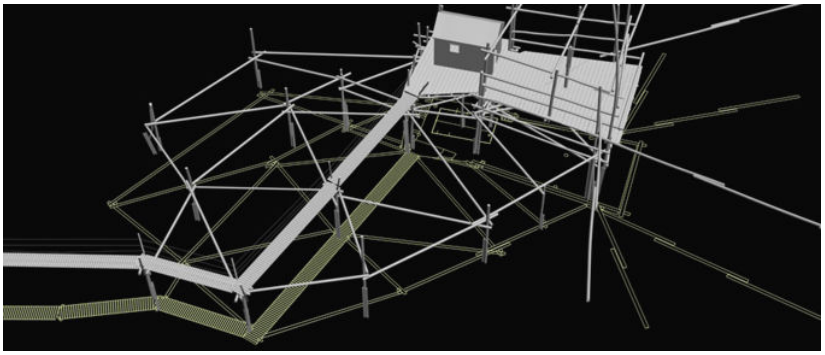

Figure 3. The two-dimensional plan as reference for the modeling

In addition to this approximate plan, a continuous analysis of the pictures was carried out made appropriately in high resolution, as 2592 x 1944 pixel). With the retouching program like Photoshop, it has been possible to make a continuous analysis of the pictures in order to make a visual proportion among the elements surveyed previously and the non-measured ones, in order to obtain a size close to the real one; to retouch the brightness of images to clean the dark parts, and consequently less visible, and underline with different colors the beams that, in some particular points, did not permit a clear comprehension of the structure.

Creating the real model has been the longest and most difficult phase. The analyzed sub-system order has been the following: the footbridge, the stable reticulum, the fishing level, and lastly the fishing apparatus. The difficulties in the model phase have been several, among which to adjust continuously the beams and piles position every time a new beam or pile was inserted searching a general balance in the position and number of elements that could be as close as possible to the formal and constructive reality and at the same time to avoid the intersection of the solids, that had to be simply fixed or put together. In fact one or more beams (18 is the incredible highest number of beams which links to a single pile) converge at every pile, and

these latter depend on other pile and so on, till they constitute a complex net of wood elements (Figure 4)

Figure 4. The complex networking relationship among some piles and beams

The most part of these modifications have been made at the vertices level, both in two-dimensional and perspective views, using sometimes movements and in other occasions, rotations or scale variations, obtaining a particular benefit by the Gizmo transformation. The whole of all these operations, caused by the problems listed previously, has conferred to the work made during the model phase a more artistic/handcraft/manual character than simply technical, through a continuous dialogue/examination with the model.

In fact, for the most part of beams and piles, I started from prisms with n-sides basis (with n variable around 14), modifying them through different transformation until obtaining every element as it is in the reality, with a number of variable sides. The main conceptual and executive approach has been applied for the other parts of the 'trabocco'.

During the construction phase of the model, I have chosen a synthesis level that would be able to communicate the irregularity of the wood elements, using a low number of vertices and sides for every solid; this is a method I learnt during the realization of three-dimensional environments for videogames (Figure 5).

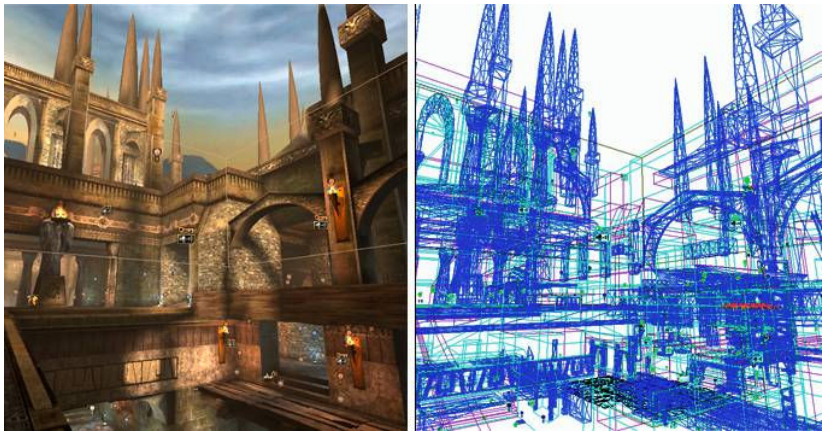

Figure 4. Geometric synthesis in the creation of complex 3D environments for videogames (personal work – UT2004 level DM-AscensionDay)

4.4. THE CREATIONS OF THE MATERIALS

Once the modeling phase has been concluded, I proceeded to the creation of the materials and textures, mainly useful to underline the different woody essences. In fact, the 'trabocco' is built with several types of timber , and we find acacia, pine-tree and fir elements. Every part of the 'trabocco' has different wood essence, depending on its functions. It is important to add this information for each element on the various detail drawings, because for a substitution of an old or broken element, we must reuse the same wood essence. The acacia for example has tens of years of resistance in water, whereas the pine-tree hasn't the same property.

Some close pictures, made on site, have been the starting point for the design of the textures in Photoshop and Gimp, and only in a few situations the materials have been defined directly in 3D Studio Max. Every texture (in total I have realized more than 70 textures) has variable size in pixel, so that it could be adapted to the single 3D objects matching their shapes. In order to avoid the troublesome tiling effect, I decided to create 2-3 versions of the same texture, each one with small variations (Figure 6) .

Even in this case, the experience gathered in a field like the one of videogames, where the materials are fundamental to increase the involvement of the player and the credibility of the environments, has been really useful.

Figure 4. Textures of the staves created in order to avoid the tiling effect

4.5. PREPARATION AND IMPORTANCE OF THE FINAL INFORMATION

Once the model has been completed, I have elaborated a list of all the drawings and the animations useful both to study more deeply the knowledge of the 'trabocco' and to create some instruments to manage recovery and maintenance interventions. At first it has been realized some two-dimensional works, such as general plans and elevations and some single sub-systems of the 'trabocco'.

From the three-dimensional model it has been possible to prepare axonometric exploded views and schedules of the technical elements of the main four sub-systems, each one considered separately. (Figure 7) For the footbridge, some axonometric views of a span and a pillar have been produced, in addition to an abacus with all the numbered technical elements, which is not possible to recuperate both live and through picture. Numbering all the single elements is essential to manage a recovery plan.

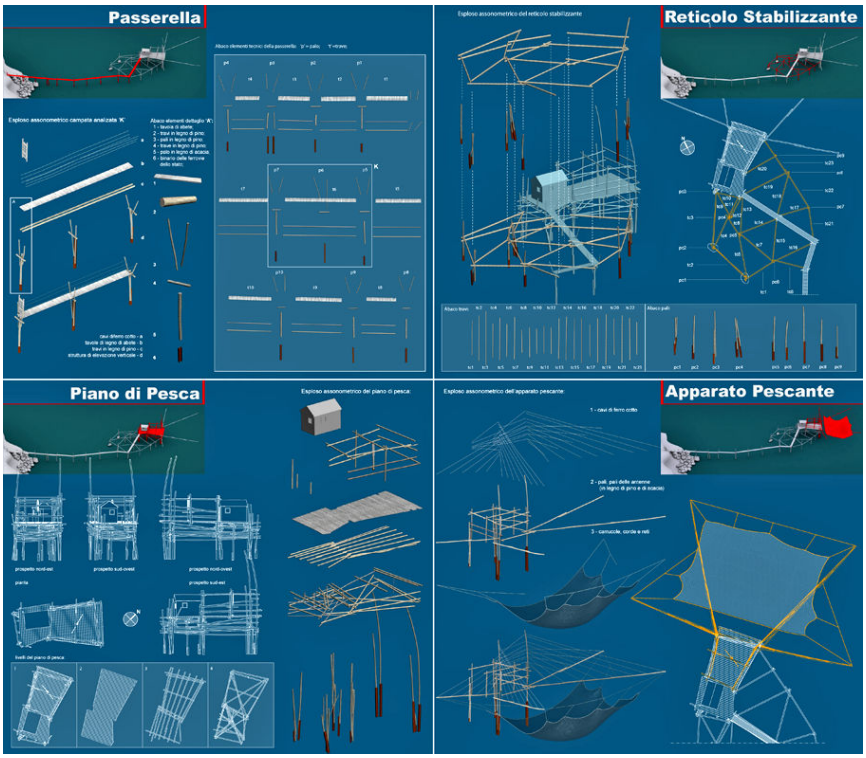

Figure 7. Drawings with the technologic sub-system analysis

The plans and elevations (Figure 8) have been completed in AutoCAD, using vector basis exported by 3D Studio Max through plug-in; all the vector drawings and the renderings have been paged in Illustrator. This is a phase of analysis, because all drawings are used as critical tools, to communicate particular details and information and give a comprehensive view of the whole object.

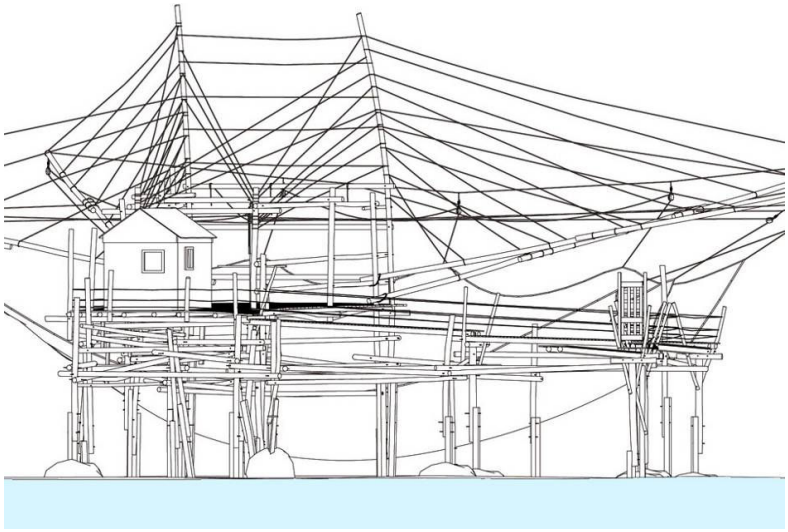

Figure 8. Example of the west elevation detail

The other products able to communicate new information compared to the two-dimensional drawings (with which they complete each other) are the animations. In total, 4 animations at 30 fps in AVI format have been realized. In the first animation I showed the various assembling phases of the elements that constitute the 'trabocco', while the other ones could be considered as virtual tour, from a low point, as we would be swimming or inside a small boat, walking along the footbridge until the fishing level. Finally, abandoning the real sights, and flying around the 'trabocco', to virtually and effectively experience new perception of the hand-manufacture. (Figure 9) On the technical side, in order to create these virtual tours I have animated some pieces to camera on routes.

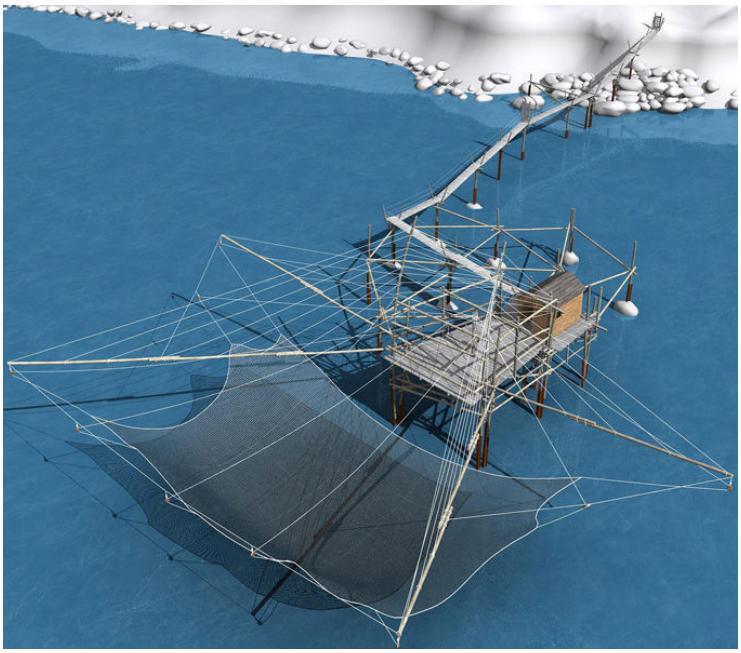

Figure 9. Example of 'in flight' rendering around the trabocco

5. Conclusion Remarks and Future Development

The use of the computer and in particular of the various graphic software packages for the graphic are always more efficient and important in the study of architectural works pertaining to the cultural traditions. This digital reconstruction of the 'trabocco of Turchinio' is an important example, because it provides us with some new and more detailed information compared to information obtained using traditional means, avoiding excessive expenses and dangers linked to direct analysis. I have only used the tools and software packages owned by the department, so the work has been quite affordable.

When we take into consideration such complicated and unique structures for the first time, we are aware that pre-arranged working methods do not exist, but it is necessary to use the various available instruments in a creative way, relying on confidence in our knowledge, acquired even in other fields, as it is demonstrated by some practical and theoretical concepts I learnt in the videogames field. The graphic programs are certainly important, but it is equally important to know how to use them and how to correlate them to overcome the difficulties one could face in order to obtain the expected results.

It is necessary to underline that this new knowledge of the hand-manufacture grows rich during all the working phases and in particular in the three-dimensional reconstruction phase, where one is constrained to observe more deeply and to raise queries on every aspect of the building. While making the model it is possible to compare it with the re-design phase.
All the information I obtained with this digital reconstruction are useful to manage and define a recovery plan and it will be part of a book, a guide for the maintenance of the Trabocchi of the coast. This methodology could be considered as a model for every digital reconstruction of other trabocchi or similar structures.
With a thought on new low-tech constructions, these hand-manufactures can also represent valid references, belonging to the local culture, for the realization of new sustainable tourist-bathing structures.

Acknowledgements

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