Geometric documentation of the flour factory 'El Puente Colgante' in Aranjuez (Madrid)

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Article Information

Abstract

The goal of this communication is to offer, through computer-aided design tools, a methodology to recover and virtually reconstruct disappeared buildings of our industrial historical heritage. It will be applied to the case of the flour factory "El Puente Colgante" (The Suspended Bridge) in Aranjuez, which was demolished in 2001.

The process is as follows: After a historical analysis of the evolution in time of the flour factory, a field work provides data allowing an info graphic reconstruction of the factory. Once this information has been processed, a lifting of the current state is made with AutoCAD, and a three-dimensional model is built with the Rhinoceros application. Then images of the ensemble are obtained with the applications Rhinoceros and V-Ray, ending with a postproduction with Photoshop.

The proposed methodology has permitted to obtain a three-dimensional model of the flour factory 'El Puente Colgante' in Aranjuez, with an accurate virtual reconstruction of its original state prior to demolition. The procedure exposed is susceptible to be generalized for any other example of industrial architecture.

1   Introduction

This communication is placed on the research line Engineering Graphics applied to industrial historical heritage, on the General Program of Doctorate in Engineering and Architecture by the head of the Research Group 'Engineering Graphics & Industrial Archaeology', Professor José Ignacio Rojas-Sola (Ph.D.), aiming to discover, classify and study the remains of our industrial past. This line is pioneer in the University of Jaen, coordinator of the Campus of International Excelence in Cultural and Natural Heritage, Quality mention by the Cience and Innovation Ministry.

We are looking to offer possible solutions to the problems faced nowadays by many examples of industrial historical heritage, such as the abandonment of the facilities, leading to a state of ruin, the interest of the owners in having a higher performance of the land, or the loss of documentation, among others.

This way, we will propose the valorization of this heritage to enable as much as possible its preservation and recovery or reuse, based on the usage of graphic engineering techniques.

2   The flour factory 'El Puente Colgante' in Aranjuez

After analyzing different pieces of information available, we thought it would be more convenient if the object of study in itself and the latter valorization was the old flour factory "El Puente" that was demolished on the Spring of 2001. This is because it is a paradigmatic example in the context of the progressive disappearance of the industrial heritage on the Real Sitio de Aranjuez. Its exceptional location, right on the access to the Real Sitio from Madrid, by the banks of the Tajo river, and views directly onto the Royal Palace and the Parterre gardens and of the Island, make this place a key point en the Villa (fig. 1).
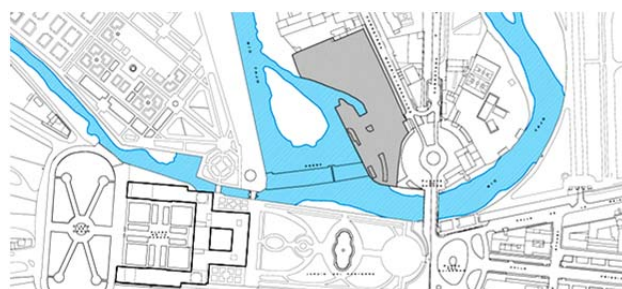

Fig. 1 Location of the flour factory 'El Puente'.

2.1   Historical evolution

The Royal Site of Aranjuez, as a playground of the Royal Family and its court has offered to the researchers, an excellent historical information about palatial architecture and auxiliary, as well as the urban designs. The industrial buildings, and specifically the flour factory analyzed, were not treated the same. The documentation on it is very rare, as it is not an artistic building, and because it is located outside the historical-artistic complex of the Villa. Although, paradoxically it is on one of the most privileged sites, in terms of visual relation with the Real Palace.

Aranjuez has shown three aspects that have defined it culturally and physiognomically, and that are in close relation the historical evolution of the flour factory.

The first of them makes reference to its origins, and is related with the arrival of the visitors of the Santiago Order who set on the XIII century and controlled meadows of the Tajo and Jarama. In this period, we know that there was a windmill which lasted until the XVth century, as well as many hydraulic mills lined along the river. The use of the water power for the benefit of men has deep roots in this historical Villa.

The second one, related to the XVI century, will define the essence of the Villa, establishing already as a Royal Site thanks to the autonomic model of illustrated agriculture that was put in place and developed to the very end, controlling the agricultural productions and developing the constructions more adequate for its treatment. This has led to a constant improvement and developments of the hydraulic infrastructures, and different projects were proposed to control water power and to get the best out of it. This aspect will end up with the start in 1820 of the so-called historical trade mill.

The third and last aspect makes reference to the boom period of the industrial revolution, which will change the existing production models. Aranjuez was depending on the agricultural production and started changing its needs. With the arrival of the train, the markets start to open. In 1908, the historical windmill is demolished and in its place the flour factory "El Puente" is born, evolving later to electric flour mill for economic reasons. Finally, after a phase of abandonment and ruins, in May 2001 the factory is demolished, in spite of the complaints of the experts in industrial heritage who mapped the place. Today, the debate on what should have been done or not with the factory is still on [2].
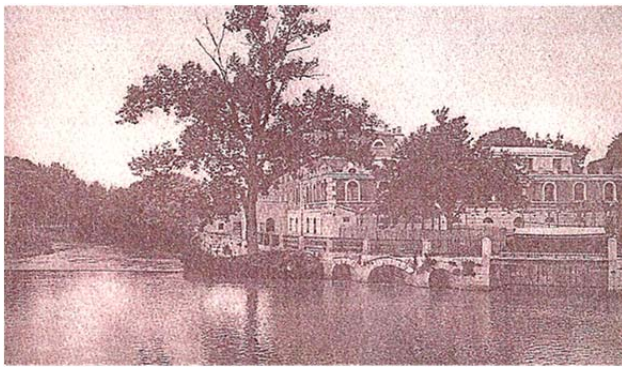

Fig. 2 Flour Factory view from the Tajo River [4].

3   Methodology

The following is a short description of the steps followed to obtain the geometric documentation of the watermill.

1. Field work to obtain trustworthy data about the current state of the foundations remains and other findings of the flour factory.
2. Processing of the information.
3. Lifting of the current state of the archeological remaining's of the factory with AutoCAD.
4. With the plans given by the technicians in charge of the demolishing and with the data processed previously, we can rebuild the volumetric of the complex with Rhinoceros.
6. Creation of images of the complex with Rhinoceros and V-Ray.

7. The images are subjected to a postproduction process with Adobe Photoshop.

3.1   Data input: Fieldwork

As there was no detailed plans of the actual state that would allow desktop work to find its geometry and dimensions, a series of tasks were used in order to gather this information.

Several visits to the site were needed to draw many defined sketches (fig. 3) of the different elements that are still on the place. A measuring tape and a Distance Meter were used to determine the heights of the spaces, and an extensive photographic report was done with a reflex digital camera.
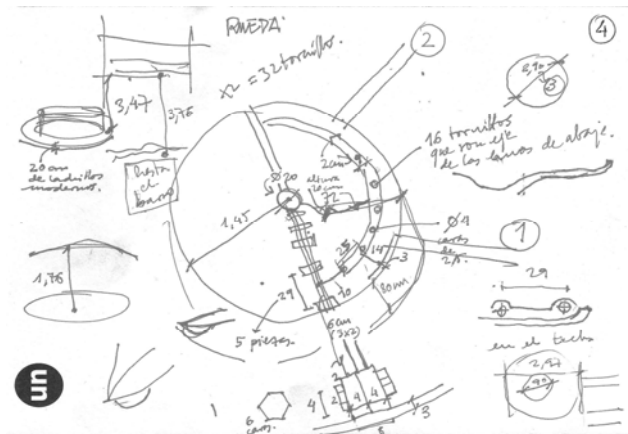

Fig. 3 Defined sketch made during the data collection.

After performing the measurements needed and the corresponding field work, we found that there was almost no trace of the old flour factory, except for consolidation works made in the millraces by the building company in charge of the demolishing that sunk the area in a marginal environment.

Following this, AutoCAD was used to lift the actual state, transferring the data obtained on the 'in situ' measurements (fig. 4).
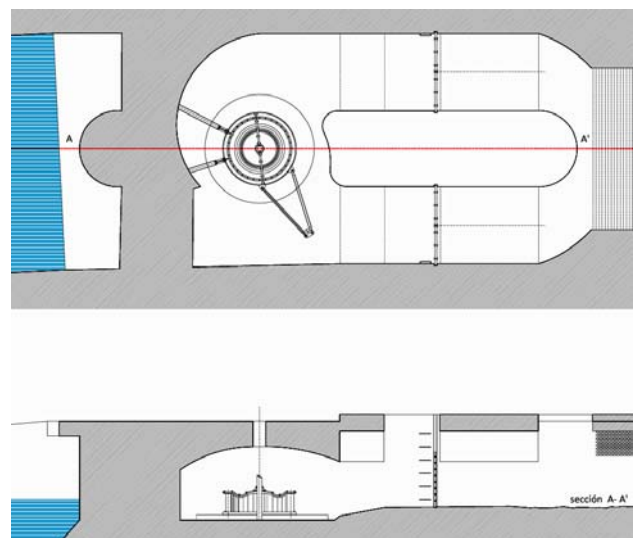

Fig. 4 Lifting of the actual (AutoCAD).

To help the process of obtaining the volumes of the factory, there was a meeting with the building company manager who executed the demolition works. He was

able to provide us with enough documentation to process (fig. 5).
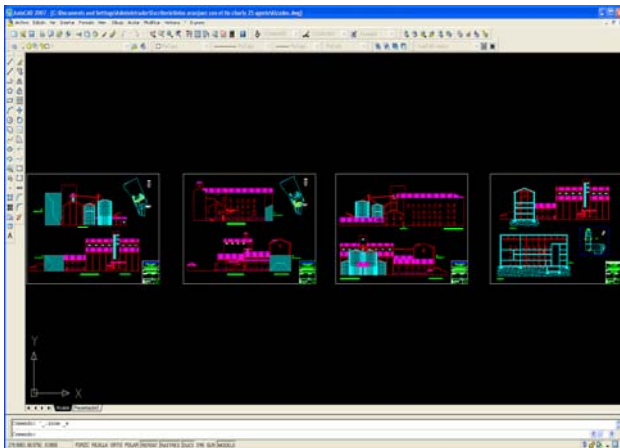

Fig. 5 Lifting for the demolition of the flour factory AutoCAD 2007. METROGES, S.A.

Given the complexity of the volumetry of the ensemble, we had to relocate the liftings in its original place, being careful with the staggerings and the correct distribution of the holes of the façade, making the plant and raising meet in order to prevent any precision mistake (fig. 6).
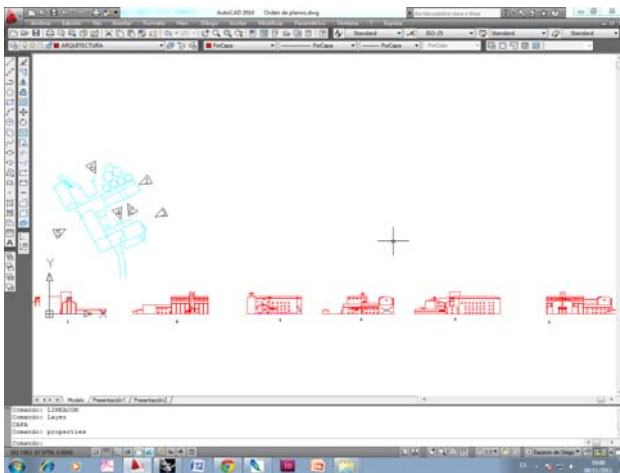

Fig. 6 Location of the liftings (AutoCAD).

Now, the pull-down views of the different buildings of the ensemble are made. This is done separately as it helps the next task on the modeling software (fig. 7).
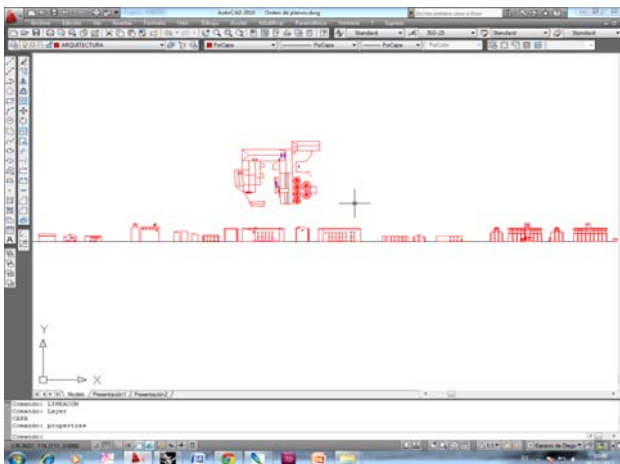

Fig. 7 Pull-down views of the different buildings (AutoCAD).

3.2   Data output: 3D Modeling

The system used by the modeling programs is very similar in all cases: starting from basic geometrical shapes, and through a series of transformations, complex volumes can be obtained by the addition or deduction of them.

We worked with parametric modeling, more precise and exact than the intuitive modeling, the latter being used by many graphic designers. We tried to give more power to the volumetric process, and no only to the final result (images).

The reconstruction works were done after the location of the pull-down views of the different buildings, using the AutoCAD file in the Rhinoceros application (fig. 8).
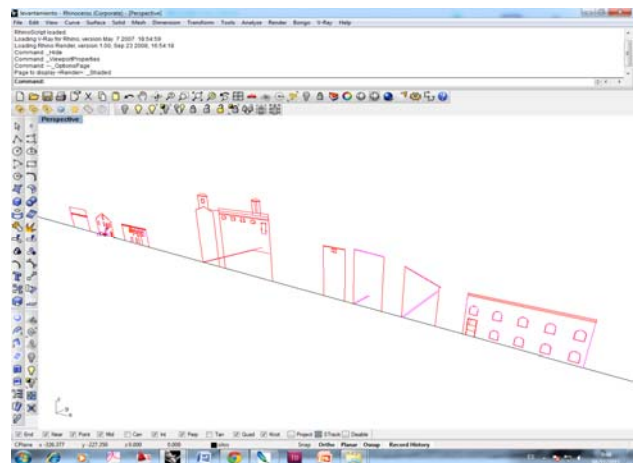

Fig. 8 File exportation from AutoCAD to Rhinoceros.

After exporting the file and locate it on the desired position - in this case, the vertical one - we started with the extrusion of the walls of the different parts, resulting in volumes (fig. 9).
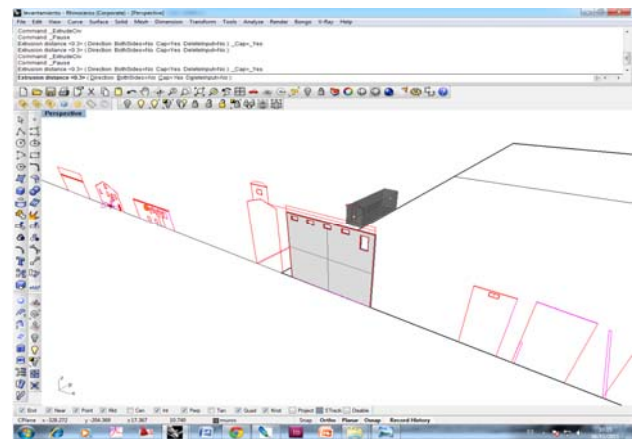

Fig. 9 Extruding first volumes on Rhinoceros.

The different completed blocks were prepared one by one in order to join them later (fig. 10).
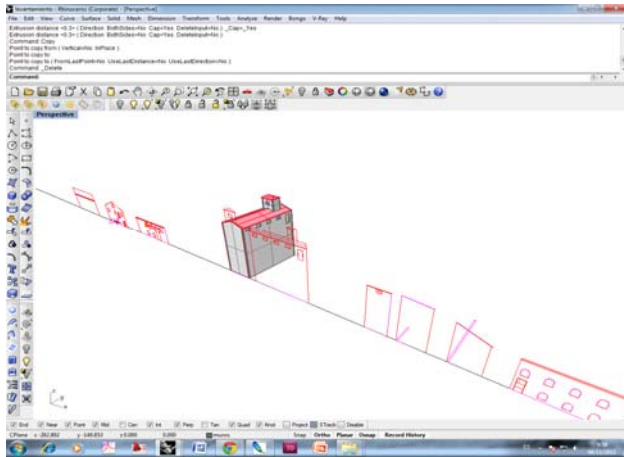
Fig. 10 Joining completed blocks on Rhinoceros.

Later on, the volumes that were already modeled were placed on the plot, over the general plans exported from AutoCAD in order to avoid precision loss (fig. 11).
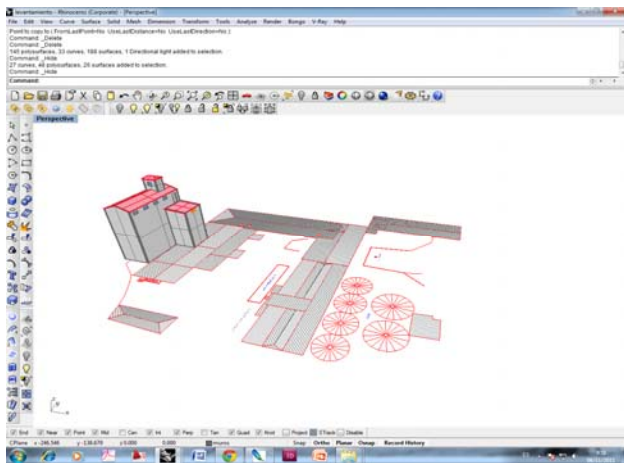

Fig. 11 Blocks are accurally placed on the plot.

After repeating the whole process, the volumetric of the set was finished (fig. 12).
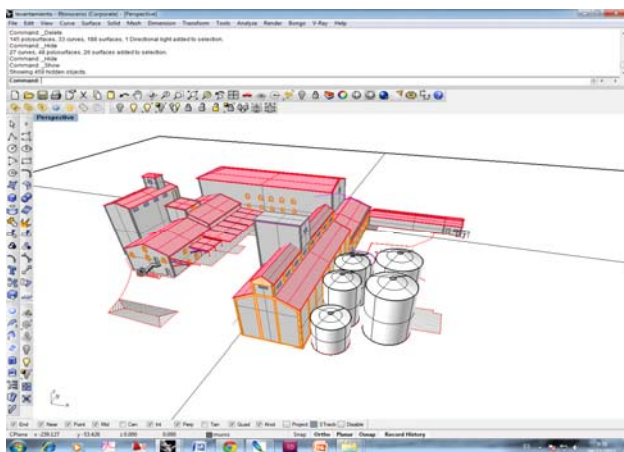

Fig. 12 The process is repeated with all the blocks.

The next step was to do the rendering, making some tests without introducing the textures, lighting, and settings so that we could see the whole factory. In order to do this, we used the V-Ray rendering engine, very complex, which makes the required mathematical calculations to visualize correctly the image (light, its refraction over the objects, etc) (fig. 13). By default, V-

Ray for Rhino has a standard illumination which let visualize the model without having to configure anything else. This is very good for the first rapid tests. We get the test rendering, and the shadows on the roofs and floor plan now reveal the volumetry of the ensemble (fig. 14).
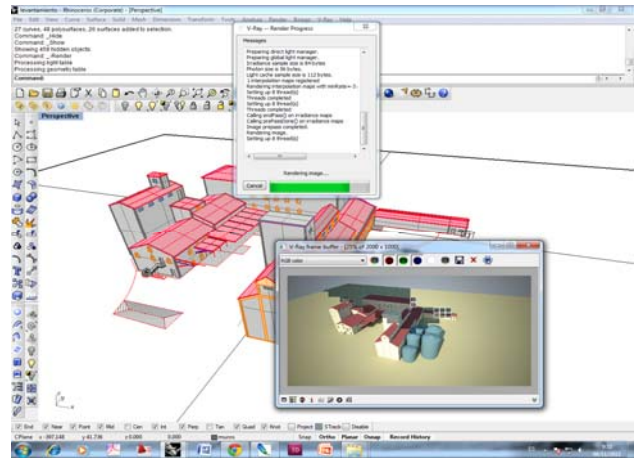

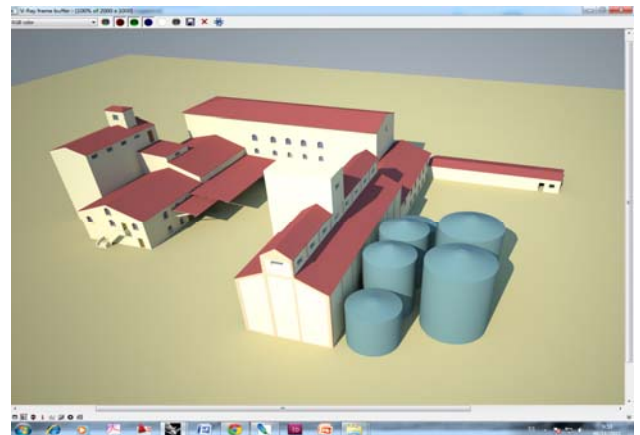***Fig. 13 Rendering with V-Ray.***

Fig. 14 Rendered test image.

Textures are now introduced to give more realism to the buildings, accessing a materials library that is in the program by defect, or creating new ones with the editor.

All the parameters of brightness, opacity, color, roughness, etc. were used, and we took into account if it was a natural or artificial material.

It is worth noting the need to give the appropriate scale to the material, as the realistic extent of the final image depends greatly on it. We then get the definitive rendering of the image (fig. 15).

Subsequently, we introduce the illumination controlled by us by the insertion of the element "sunlight system". Basically is the representation of a sun with its settings allow us to orient conveniently control their intensity.

To adjust the illumination of our model to a real image, for example as BING pictures below, we have focused the sun in a similar way to generate shadows as close to the actual photo, so that when we superpose the two images (real and render), the directions of the shadows, shaded faces of buildings, etc ... match perfectly. Moreover, regarding the illumination are set two important points:

The calculation of diffuse light bounced is made with "GI (Skylight)". We configure so that the software calculates the new "sun" introduced in order to generate a "background" from it (the program will create a sky from the position of our sun).
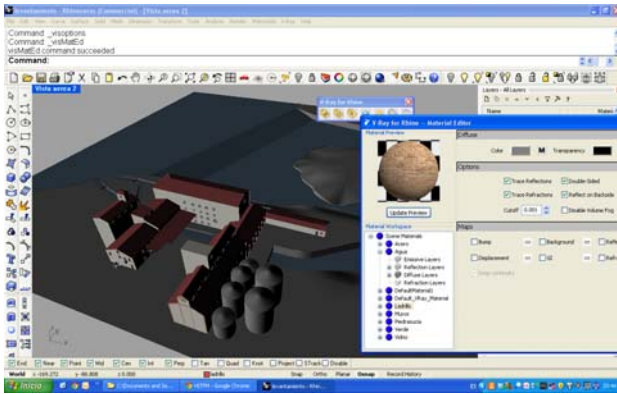
Fig. 15 Rendered image.

Finally, we can improve the performance and speed of our changing render by using another render engines because the parameters that come by default in that software are not the best. For this case we have chosen to "Irradiance map" as the first engine to calculate light and bounces on the surfaces thereof to the point of view of the camera and "Light Cache" as the second engine, which calculates the light rebounds well from the point of view of the camera, and will further clarify the render.

We have also helped with a tool that brings V-ray called "Physical Camera", and serves to control parameters by means similar to a real-SLR camera, the light entering into images can be filtered it as you like.

Finally, Adobe Photoshop was used in the postproduction phase. This extremely versatile editing and retouching application was put to action to eliminate possible defects that could have appeared, and to work on image effects (fig. 16).
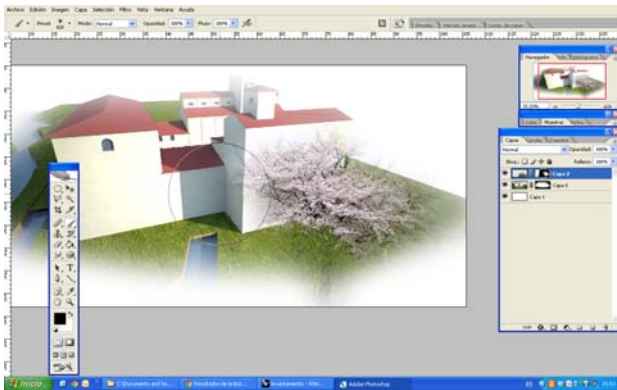

Fig. 16 Edited image with Adobe Photoshop.

3.3 Geometric documentation

From an engineering point of view, a reliable tridimensional modeling is an excellent tool as it allows a precise study of each element of the model. It also bring a global idea of how they integrate with each other.

Thus, from the defined sketches we did a lab work in order to get a solid model in three dimensions. AutoCAD software was used as it is a very precise tool that allows controlling parametrically the drawings optimizing resources. AutoCAD generates not only the plans of the places, but also the bi-dimensional design of the different elements studied. It brings plans, lateral views and sections that have helped to obtain later the model in three dimensions [5].

On the same process line, Rhinoceros is the software tool used to raise the three-dimensional model of the old flour factory. Because of its direct connection to the

NURBS modeling of free shapes, this software has the characteristics a precision needed to ensure the intended results [6].

4 Results

Below we show the results with the three-dimensional modeling of each element belonging to the flour factory 'El Puente Colgante' in Aranjuez.

In the first place we located the building in its environment, through a series of collages, looking for a better understanding of the place, the occupation, the volumetry and the real implications of being situated near the Royal Palace.

To make theses photomontages, we needed a rendering of the ensemble with a fixed reference of the existing environment. This was in order to locate it in an appropriate scale, and without distortions on the previous assembly with Microsoft's.

When making the overlapping of the flour factory building, we can clearly see the ensemble as it was before the demolition in 2001.

We can also appreciate the contrasts caused by the scaling-up of the factory, and how the main façade was though to face the river, slim and clean in contrast with the Palace, bringing the activity inside the walls.

Three montages were made, the most representatives. I.e., the ones that have brought us the needed information (figs. 17 to 19).

Fig. 17 West view rebuilt on BING montage.

Fig. 18 North view rebuilt on BING montage.

Fig. 19 East view rebuilt on BING montage.

The proposal for the main façade aimed to clean the staggering volumetry, offering to the façade the river, and to the Palace a neat and simple volume. We can appreciate the double slops of the millraces, in which the main millrace (the one that runs on the interior of the parcel and under the factory) will remain bound to electric production. Meanwhile, the millrace located next to the river will be used to produce flour (fig. 19).

4.1 Architecture

The following image shows the importance the ensemble gets in the interior of the place. The convincing volumetry next to the river was disaggregated, showing an interior much more dynamic, specific to a work space in constant change (fig. 20).

Fig. 20 West view of the flour factory.

The image that follows the proposed path shows the richness of the existing spaces, in the area of the building that is more protected. We can see the division of the millrace in two nozzles. We can see the division of the millrace in two nozzles by the inclusion of two arches of apiary stone Colmenar on the brick walls, in order to increase the pressure of the water on the generator and to make easier the task cleaning of the same (fig. 21).

Fig. 21 South façade view from the millrace.

In the two images below, the built volumes are not

easy to understand due to presence of the pergola shape spaces in south facade, designed to protect from the Sun (figs. 22 & 23).

Fig. 22 South west facade view of the factory.

Fig. 23 South west façade view of the factory.

There is a clear contrast between the walls and the north face, we can see that cloths lack of hollows except in the central volume which is higher and more modern, probably aimed at the offices of the Factory (fig. 24).

Fig. 24 North-West view of the factory.

The last section of the proposed sequence attempts to cover the south facade, where stood the grain silos next to the waste water drain after the passage of the same by the generator. This facade, much more stepped than the previous views, shows a set of disparate elements together articulated through the various uses that proposes the factory. The eastern façade which has dissolved isn´t clean much more time (fig. 25).

Fig. 25 South façade view of the factory from the drain.

To end the sequence an image is displayed in which reconnected clean water for electric power production after the jump River Tajo dam (fig. 26).

Fig. 26 General view of the factory after the jump dam.

5   Conclusion

The three-dimensional model of the flour factory 'El Puente Colgante' in Aranjuez preserves at least the virtual reconstruction of one of the demolished buildings what was once the Royal Industrial Heritage Site. Similar processes can be recreated with other examples of Industrial Heritage, now disappeared, in order to form virtual repositories to preserve them.

Acknowledgement

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