

SCANNING OF ANTONIO GAUDI'S ORIGINAL IMAGES OF HIS DRAFT FOR A CHURCH IN BARCELONA

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ABSTRACT:

The original non-metric photographs of Antonio Gaudí's model dating back to about the year 1900 have been detected some years ago in a Catalonian architectural archive. These are probably the last existing ones because the rest of them had been destroyed during the Spanish Civil War in the 1930s.

The problems during this first scanning of these outstanding and sensitive original photo glass plates (some of them were broken, split apart and had to be restored digitally) will be presented in this paper.

This task is only the first step for a photogrammetric restitution of the cord model. So Gaudí's original ideas and concepts for that church will be available combining the ongoing recording of the existing crypt with the results of the photogrammetry.

1. INTRODUCTION

About 100 years ago the famous Spanish architect Antonio Gaudí spent ten years working on studies for the design, and developing a new method of structural calculation based on a "stereostatic model" built with cords and small sacks of pellets. The outline of the church was traced on a wooden board (1:10 scale), which was then placed on the ceiling of a small house next to the work site. Cords were hung from the points where columns were to be placed. Small sacks filled with pellets, weighing one ten-thousandth part of the weight the arches would have to support, were hung from each catenarian arch formed by the cords. Photographs were taken of the resulting model from various angles, and the exact shape of the church's structure was obtained by turning them upside-down. So architect Gaudí could prove vertical sections or elevations of the building.

Only the crypt itself has been built of a planned church in the Colonia Güell near Barcelona, Spain. Then the construction had to be stopped because of the outbreak of World War I. The church is regarded to be a first test for Gaudí's ideas of the more famous church "La Sagrada Familia" (UNESCO World Heritage List) which is still in a building process nowadays.

These original photo glass plates have been rediscovered in an archive at CITM/UPC in Terrassa / Barcelona, Spain. Unfortunately some of the plates had been broken during the decades and even some of them have been repaired with unexpected methods. The images were scanned in April 2006 both for documentation as well as seen as a first step for further photogrammetric processing and reconstruction for a virtual model.

2. PROBLEMS DURING SCANNING PROCESS

All photo plates have been measured in advance with a precision rule to document the exact negative size. Also all plates have been photographed from both sides.

The hardware used for digitalization of the originals was an Epson Perfection 4990 Photo Scanner with a physical resolution of 4800 ppi.

The scanner has been calibrated regarding radiometric and geometric distortion which has also been repeated three times a day. For this purpose an IT8 calibration pattern and a regular 5mm grid has been used.

With an actual negative size of 90 mm x 120 mm one scan needed about 15 minutes and lead to a file size of about 1.2GB (16bit grey level, TIFF format uncompressed)

All of the 19 negative photo glass plates have been scanned this way. Three of them somehow had been broken several years ago.

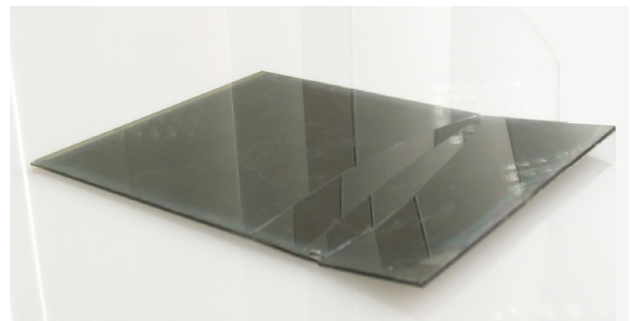


Fig. 1: broken photo plate OM 04

Photo OM 04 was broken near the centre line and provisory glued with tape. Two more cracks are in the lower part of the plate which divides it all together into four parts. Probably because of a tension arising from the tape, the different pieces did not lie in a plane so the plate could not be scanned by

pressing it down to the scanner surface without damaging it or at least of its repair.

Another broken photo (OM x) had been repaired by simply sticking the different parts at the glass side onto a transparent adhesive film.

It was impossible to clean the plates from sticky rests or even peel off the glued parts from each other without damaging the photographic emulsion. So they had to be scanned "as is" and a different way had to be found to restore the originals as good as possible.



Fig. 2: broken photo plate OM x

The third broken photo plate (OÜ 03a) was only split in two parts.

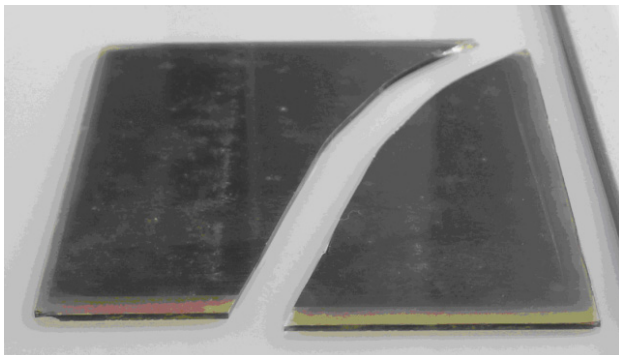


Fig. 3: broken photo plate OÜ 03a

3. DIGITAL MODEL FOR THE RESTORATION

3.1 Projection and completion

During the digitization the photo glass plate is enlightened from above with orthogonal and parallel rays and the scanner converts the light into a digital image. Because of the deformed shape of the scanned negatives the resulting images are distorted (see fig. 4).

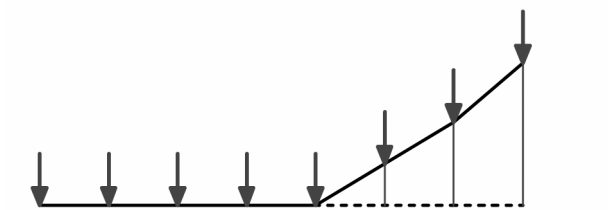


Fig. 4 scanning of deformed photo glass plates

For the restoration the digital picture is projected back - parallel to the scan direction - on a virtual 3D model of the deformed glass plate (see fig 5). This digital projection was done with 3D-Studio MAX software. (Hanke, K. et al. 1999)

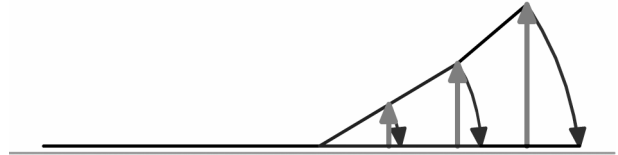


Fig. 5: Back projection and development of the virtual model

This procedure leads to a digital model with the original negative used as texture of the 3D glass plate model. The individual broken parts are then developed to their original flat geometry.

3.2 Transformation

The features of any digital imaging software (e.g. Adobe Photoshop) can also be used for a correction of the distorted scanned images.

Using CAD software those broken parts are again rebuilt digitally as a 3D model. For the further processing, the spatial angles between the flat part and the broken parts are measured digitally.

The deformed parts are then brought in their right size and shape by common image processing utilities as "free transformation" where the spatial angles lead to the wanted correction of the parts.

4. TESTS

Investigating of the accuracy and feasibility of above procedures some testing was accomplished. For the first test with CAD software a square with a reseau grid of 5 mm (see fig. 6) was used and artificially inclined along the diagonal by 60 degrees. The resulting image was "restored" with both procedures mentioned above.

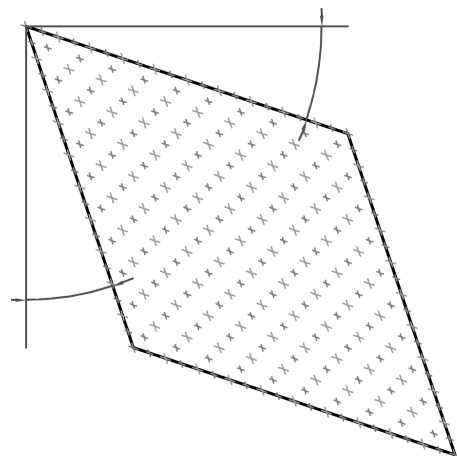


Fig. 6: inclined test grid

In both cases the comparison with the original illustration showed a difference of up to two pixels, dependant on the original quality of the picture.

The next attempt was already a preparation for the final restoration process. Into the already created virtual 3D model of the broken parts of the photo glass plate a regular grid of 5 by 5 mm was “digitally engraved” (see fig. 7).

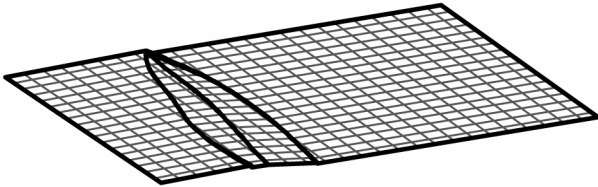


Fig. 7: virtual 3D model of the broken glass plate

The individual pieces of broken glass were then digitally separated and developed as described above. After that the fragments were united and compared with the flat original. Again a difference of up to two pixels was noticed.

5. PHOTO RESTORATION AND RESULTS

With the attitudes and values of the last test, 3D model with raster, we repeated the completion of the glass plate. With the software 3D max again the digital projector was provided. Since image files with a size of 1.2 GB cannot be processed with Photoshop the scanned images had to be prepared. A reduction to 8 bit and a division into smaller parts were necessary.

The individual fragments of the image were split into picture sections of approx. 50 Megapixels (ie. max. rendering size of the software).

Using the second way - transformation with Adobe Photoshop - the pieces of broken glass were “free transformed” with the measured angle from the earlier test.

In contrary to the processing with 3D MAX it was here possible to keep the 16 bits gray tones of the digitization and avoid splitting the parts to divisions.

Comparing the digitized image with the restored one the differences are around. 30 pixels regarding an image quality from 4800 dpi (see fig. 8 for a comparison).

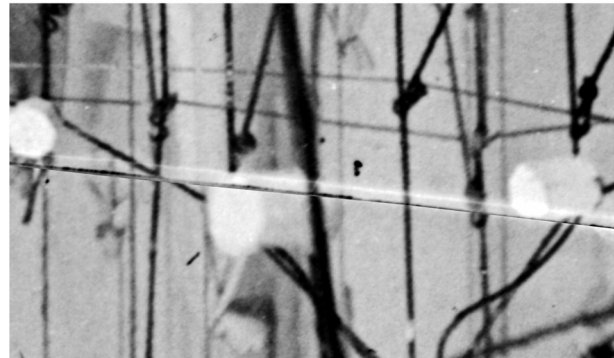
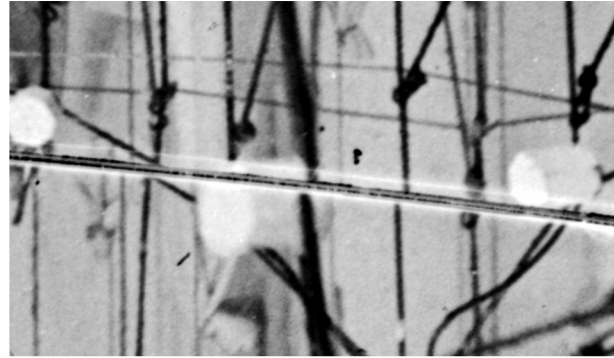


Fig. 8: Pre and post situation of a small detail of the image

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