

A new approach for art reproduction. The Altarpiece of Guimerà project.

Jordi Sender. Large Format Printing – Imaging and Printing Group. Hewlett-Packard. Sant Cugat del Vallès, Spain.

Abstract

This paper covers a new approach for art reproduction, using digital printing technology. It describes a real case, the reproduction of the Altarpiece of Guimerà, a XV century masterpiece of Catalan Gothic painting. Due to its dimensions and its irregular surface caused by wood aging (deformations, cracks) and moldings, the entire process became a real challenge.

The objective is to experience the same feelings in front of the reproduction as to the original by means of accurately reproduce the image, the volumes and the texture.

It describes the key steps along the project. That is, capturing the image (digital photography), measuring (3D non contact scan) and reproducing (wood milling) the three-dimensional physical reality and finally printing the image (with Thermal inkjet UV inks) on a flexible and elastic material (Papergel) that is later on applied on top of any uneven surface or volume, thus transferring the ink layer onto it.

The replica is already installed in its location, proving that this technique opens new possibilities in the field of art reproduction and cultural heritage preservation.

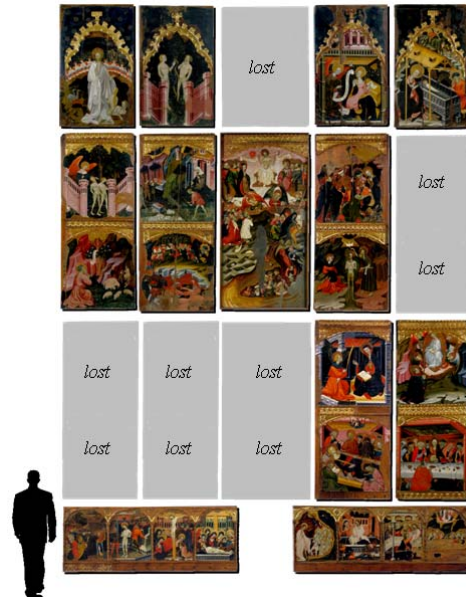


Figure 2. Original configuration of the altarpiece showing its relative size to people. Nine of the original tables are currently lost

Introduction: the altarpiece of Guimerà.

On 1402 Ramon Galceran de Castre instructed Ramon de Mur to create a magnificent Altarpiece, which it took 10 years to be completed.

The Altarpiece of Guimerà [1] belongs to the Catalan International Gothic Style painting, defined by the elegance of forms, the removal of gold in the backgrounds and the extensive use of colors.

It's a very interesting piece, due to the use of perspective; also due to the architecture, furniture and dressings being showed.



Figure 1. Front and rear view of one of the tables of the altarpiece

Ramon de Mur used tempera painting onto fabric covering a support of walnut wood. Moldings are made of pine wood.

Original size of this piece was 7,30 x 5,24 m, one of the biggest by the time. It was formed by 32 tables (only 23 of these tables have last to our days, the rest have been destroyed or lost).

The piece was kept in its original position in the village of Guimerà (Catalonia, Spain) until 1865 when it was dismantled and later on, in 1888, it was sent to Barcelona for the Universal Exhibition and finally, to the Episcopal Museum in Vic [2], where it has been exposed for the last century.

Tables have been rearranged in a new configuration [3] to easy the visualization and adapt it to the dimensions of the exhibition room, where it is kept under most suitable temperature and lighting conservation needs.

The project [4]

Project execution was a long process that took over 4 years. We faced 3 main challenges:

- Identify the technical solution that would enable to accurately replicate the image, the volume and the texture.
- Obtain permissions from Vic's museum for the digital capture and from the Diocesan Delegate for Artistic Heritage, and Holy art to install the replica in the church of Santa Maria (Guimerà).
- Obtain the required financing: after several unsuccessful attempts in search of support, both from public and financial institutions to which we addressed, the patronage of individuals is what has made this project possible. From here our gratitude to these people.

Capturing the original

The Altarpiece was scanned to capture its three-dimensional physical reality and store it in a computer as a point cloud that represents the digital model of the real object.

Technology used (developed by Nub3D), digitalizes in every shot a whole area of the real object so in a few seconds, hundreds of thousands of points (10,000 points/cm²) are being captured to accurately describe the shape of the surface.

TripleArt [5] is a transportable measurement system adapted to the restrictive rules of museums and conservation of cultural goods (such as avoiding physical contact, control of the intensity of light -150 lux- that the object receives or the elimination of electromagnetic bands that could damage the work).

The measurement process called structured white light triangulation is divided into:

1. Project a series of black & white fringes onto the surface to be measured.
2. Capture a series of images of the part showing the deformation that the lines of light suffer.
3. Analyze the deformation suffered by the lines reflected on the object's surface and calculate a cloud of 3D points (x, y, z) of the surface

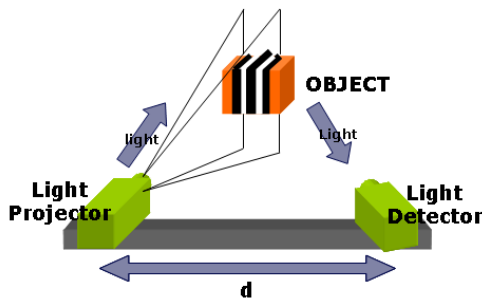


Figure 3. TripleArt measurement system scheme

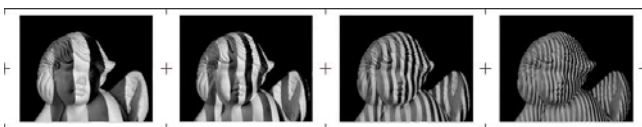


Figure 4. White vertical illuminated strips are projected. The three-dimensional information is obtained by analyzing the deformation of the projected lines that occur when reflected on the object's surface (SIDIO measure system).

To obtain the complete geometry of a piece, it is usually needed to measure it from different points of view. All measurements must be referenced in a global coordinate system. This process is called registry and uses an exclusive automatic referencing system without contact called MML (based on the projection of optical markers onto the part, that is, the light coming from the projectors creates thousands of virtual markers on the surface of the part which allows the joining or automatic registration of the different positions of the object).

Finally, TRIPLE software manages all measurements and generates the three-dimensional digital file in a STL format (widely used for rapid prototyping and computer-aided manufacturing). Surface is broken into a logical series of triangles. STL file is a complete listing of the xyz coordinates of the vertices and normals for the triangles



Figure 5. Each table of Guimera Altarpiece required of several measurements to capture its three-dimensional reality.

Altarpiece image was obtained via digital photography. Each table required of several frontal photos to achieve the required level of detail and to discard undesired light reflections.

Characteristics of the generated files are:

- Image dimensions 7096x17224 (122.2 MP)
- Uncompressed size: 349.7 MB
- Bit-depth: 24-bit Color

Reproducing the volumes

The 3D information is used to machine the wood support in a milling machine.

The base of Wood chosen was a 50 mm thick block of Medium-density fiberboard (MDF) (Wood fiber finely shredded, glued and hot-pressed). MDF was chosen due it is more stable, uniform and less deformable than the solid wood.

Machining process required 4 different passes changing tool caliber to achieve the required level of detail in the reproduction. Machining time for each table was approximately 1.5 days.



Figure 6. Milling process and table sample

Printing the images

Images were printed using Thermal Inkjet technology. Printer selected was a HP Designjet 5500 and 83 UV inks [6].

Characteristics of this printing system are:

- Large format printer (1.52 meters width) enabled to get every table from a single print which easy the ink transfer process.
- Inkjet printing technology (up to 1200x600 dpi) with 6 colors (cyan, magenta, yellow, black, light cyan, light magenta).
- 2 ink systems (dye and pigmented). Ink set used was the pigmented one which delivered the required durability (light & ozone fade) and its compatibility with Papelgel media was already qualified.
- Automatic closed-loop color calibration ensures consistency of color throughout the entire job run, from the first print to the last.

Other options such as the HP Designjet Z6100 Photo Printer [7] (2400x1200 dpi printing, VIVERA pigmented inks, 4-6 pl droplets, built-in X-Rite spectrophotometer), which provides a significant improvement in terms of Print Quality (reduced dot visibility, smoother transitions, extended color gamut and permanence, higher color accuracy/consistency, less mesmerism...) was discarded by the time due to the compatibility of VIVERA inks with Papelgel material was not qualified yet.



Figure 7. HP Designjet Z6100 (left) and 5500 (right) printers

Photographic files for each table were processed on a PC using Photoshop software.

In case original object to reproduce shows significant variations in depth, several photos from different angles need to be combined and later on distorted with the help of an specific software, so we ensure they will accurately match the reproduced 3D volume.

In our case, the altarpiece surface is relatively flat, so we skipped this process (assuming some minor inaccuracies). Papelgel elasticity gives enough margin to adapt printed image to the MDF volumes.

Finally, images need to be mirrored thinking in further ink transfer.

Color required some manual adjustment to maximize color matching to the original.

Transferring the ink onto the 3D wood base

Image is being printed on top of Papelgel media [8].

Papelgel is a flexible and elastic material that can be applied on top of any uneven surfaces or volume, opening new possibilities in the field of art reproduction.

Papelgel is a gelatin material [9], looking very similar to the conventional photographic quality papers when it's dry. Thus, it is fully compatible with HP Thermal Inkjet printers.



Figure 8. Papelgel material being printed in a HP Designjet 5500 as any other conventional photo media

After printing, material is moistened, and, in certain cases, heated at a temperature comprised between 35C and 45C approximately.

This simple operation changes the physical properties of Papelgel. In a few seconds, it becomes elastic and adhesive, and therefore adaptable to any surface or volume that want to decorate.

Papelgel printed side is glued. This operation moistens it. As mentioned above, material becomes flexible.



Figure 9. Papelgel printed side is glued to moisten it and later on transfer the ink layer on top of the machined

Next step consist in the transferring the ink onto the machined MDF base. In order to ensure the accurate positioning of the printed image respect to the base, it is required to print some reference marks on the back side of Papelgel. Most recent revisions of this material are translucent so it eases the process of manually adjusting the image onto the base.



Figure 10. Papelgel is applied onto the MDF base. Reference marks easy the correct positioning.

Papelgel is finally removed. Printed image has been transferred, obtaining the illusion of being in front of the original.



Figure 11. Papelgel removal. Ink transfer is completed.

Then, it took place the only manual process in the whole project: the gold painting. The whole reproduction is finally protected with the application of a varnish layer.



Figure 12. One of the Altarpiece tables replica is completed

The final result



Figure 13. Guimerà Altarpiece replica installed in the Church of Santa (Guimerà)

References

- [1] Detailed information of the Altarpiece, available online in: <http://www.guimera.info/galeria/sala3/sala3.htm>
- [2] Vic Episcopal Museum Gothic Painting Collection info online: <http://www.museuepiscopalvic.com/colPintGot.asp?idm=EN>
- [3] Current configuration of the Altarpiece in Vic's museum: <http://cultura.gencat.cat/acceptacio/cultura/patrimoni/retaleguimera/>
- [4] La reproducció del retaule de Guimerà/The reproduction of Guimerà altarpiece: <http://www.prousweb.com/ftp/reproduccio.wmv>
- [5] TripleArt measurement technology without contact: <http://www.nub3d.com>
- [6] HP Designjet 5500 Printer series - overview and features: <http://h10010.www1.hp.com/wwpc/us/en/sm/WF05a/18972-18972-3328061-12600-3328080-82218.html>
- [7] HP Designjet Z6100 Printer series - Overview and Features: <http://h10010.www1.hp.com/wwpc/us/en/ga/WF05a/18972-18972-3328061-12600-3328080-3338748.html>
- [8] Papelgel material available at www.papelgel.es
- [9] Julio Gomez Portela, Utilization of gelatin in the form of sheets used as a support for images and the transfer thereof to surfaces or to tridimensional bodies (WO/1999/049364).

Author biography

Jordi Sender received his ME degree in Mechanical Engineering from UPC, Barcelona (1991). He has worked in Hewlett Packard company, holding different engineering and management positions in Manufacturing and later on in R&D department for Large Format Printing Business.

He is a member of [guimera.info](http://www.guimera.info), a non-profit organization that promotes artistic and cultural activities and the use of internet as an effective tool of communication in the Corb Valley area, Catalonia (Spain).