Reconstructing the Shigiory Torbinata: Using 3D scanning as a tool for conserving the work of Ferdi

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4D Research Lab

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Project datasheet

Name project	Bonnefanten Shigiory Torbinata Restoration
Date (from – to)	18/10/2022- 20/06/2023
Author(s) of report	Alicia Walsh, Tijm Lanjouw, 4D Research Lab
Project initiators	Charlotte Franzen, Head of collections, Bonnefanten Paula van den Bosch, Senior curator contemporary art, Bonnefanten Ellen Jansen, UvA, Conservation & Restoration Katja van de Braak, Independent restorer
Execution	Tijm Lanjouw, 4D Research Lab: 3D scanning and processing Alicia Walsh, 4D Research Lab: 3D scanning and processing
Scientific advice	NA
Delivered product(s)	3D model of the scan PNG image file of the pattern reconstruction 3D model with the reconstructed pattern
Where to access main outcomes/product	Bonnefanten Museum, Maastricht
Location and accessibility of project files	4D Research Lab archive, cloud storage. Available on request at the 4D Research Lab. Contact Tijm Lanjouw (t.j.r.lanjouw@uva.nl).
Related publications	NA

Figure 1. Shigiory Torbinata

Shigiory Torbinata — Bonnefanten Maastricht

Introduction

This scanning project was commissioned by the Bonnefanten Museum's Head of Collections and UvA's Conservation and Restoration team to restore an artwork held at the museum. The sculpture has experienced extensive damage over time due to handling and sun exposure and is undergoing restoration by independent restorers at the Bonnefanten and in Amsterdam. This project aims to assist in this restoration by 3D scanning the damaged areas of the sculpture in order to digitally restore it to its original colour pattern, which will then be 3D printed onto new fabric to replace the original damaged area.

Art-historical context

Entitled *Shigiory Torbinata*, the artwork was produced in 1966 by the Dutch artist, Ferdi Tajiri (1927-1969). Part of a larger collection called *Hortisculptures*, this particular sculpture depicts a tall flower with tentacle-like petals, a long stem, and rests in a wicker basket with leaves protruding out of it (fig.1). It is made from copper, iron, polyurethane, silk and artificial fur, and measures at 196cm high and 60cm in diameter (bonnefanten.nl). The stem is the area that has experienced the most damage and is therefore the focus of restoration.

Method and technique

3D scanning using the Artec LEO was chosen as the documentation method because the main aim is to capture the geometry of the sculptures' stem, and this scanner offers a fast and high-resolution result and a decent texture quality (fig.2). Photogrammetry would not have been a reasonable option for documentation, as it was not necessary to have a high-resolution textured model of the stem as it appears currently, faded due to sun damage. The reconstruction of the original colours was based on the recorded data of three chosen *tentacles* that had not experienced such damage (fig.4). In this way, we can colour match the faded areas on the stem with the pattern still visible on the tentacles. For colour recording, a cross-polarised photographic setup was used. With this setup, both the camera lens and the light source are fitted with a polarising filter (Walsh & Lanjouw 2024). The filters together negate most specular (white) reflections. On matted surfaces, the reduction of external lighting increases the saturation and contrast (Clini et al. 2023). This ensures that only the diffuse colour is recorded on the image.

Figure 2. The Artec LEO in use.

Recording and processing

3D Scanning & colour recording

The Shigiory Torbinata sculpture was recorded using the Artec LEO to capture its geometry and texture. Multiple scans were made with the Artec LEO with varying settings to compare their results. The settings that varied are summarised in Table 1, and include the frequency of High Definition (HD) frames, and various texture settings. Two scans failed, while the others did not result in notable differences from each other. It was therefore concluded that increasing the HD, which significantly increases the amount of data, does not affect the quality of the scan.
A Nikon D5300 with 50 mm lens and a ring flash light (Godox Wistro AR400) were used to record the original (or close to original) colour.

Scanning conditions and setup

The sculpture was scanned inside the museum, in natural lighting (fig. 3 and 4). The large leaves that protrude from the sculptures' basket were removed during scanning so that we could also document formerly covered areas. This area does not show any sun damage and reveals the original colours of small parts of the pattern. These areas were however not used as a base measurement for the colour restoration as it would potentially contrast too much with the tentacles that are to be left

Geometric 3D scanning	
Scanner model	Artec LEO
Technique	Structured Light Scanning
Date	18/10/2022
Location	Bonnefanten Museum Maastricht
Resolution	Max 0.2 mm
Number of scans	10
Scanner settings	(Settings changed over 10 scans) HD data: 1/8 or 1/4 Save supplementary textures: 0, 6, or 15 Texture flash: OFF or ON Texture exposure time: 14, 30, 100, or 300 Texture brightness: 33%

Table 1. Scanning datasheet.

Photometric colour recording	
Camera model	Nikon D5300
Camera lens	Nikon 50 mm with polariser filter
Lighting	Ring flash: Godox Wistro AR400 with custom made polariser filter
Technique	Cross polarised photography
Calibration	Xrite colourchecker passport
Date	18/10/2022
Location	Bonnefanten Museum Maastricht
File format	Raw (.NEF)
Resolution	6016 x 4016
Settings	ISO: 100 F-stop: f/11 Exposure time: 1/200 sec

Table 2. Colour recording datasheet.

Figure 3. Scanning setup with the Artec LEO (image by authors).

Figure 4. Setup for documentation of the colour with cross-polarised photography. Highlighted areas of tentacles used for colour matching (image by authors)..

untouched by the restoration. Instead, the slightly faded areas of the tentacles were used for the colour recording with the DSLR camera.

For the recording of the colours, the restorers pointed out patterns on the tentacles that matched areas on the stem. These were photographed under the same lighting conditions as the scans, but using a double polarized setup (fig. 4). The influence of external light through the windows was tested under the fast shutter times required for flash light photography, and found to be negligible. Therefore, there was no need to darken the room.

Post-Processing

The post-processing of the scan involved (1) the creation of a 3D mesh model from the scan data, (2) using the model to project the fabric pattern on a perfectly rectangular flat surface, (3) tracing and filling the pattern using graphics software, and (4) exporting it for print. The used softwares and steps are summarized in the table below.

The post-processing of the photographs involved colour calibration and white balance adjustment.

Scan post-processing technical details	
	Step 1: importing and 3D mesh model
Software	Artec studio
Procedures	Import from Artec Leo HD: 312 frames, 204 texture frames, 31M polygons, 0,2 max error Rough serial registration: geometry and texture Fine Registration: geometry, subsampling 0,05 Global Registration: geometry, key frame ratio 0,3, search features within 10mm Automatic Alignment Sharp Fusion: 3D resolution 0,3mm, max error threshold 0,8, HD sensitivity high Texturize surface: 4096 x 4096
Output	Format: .GLB Polygon count: 2.368.923
	Step 2: projection on flat surface
Software	Blender
Procedures	Create cylinder matching scanned object Assign matching seam lines Projection of cylinder on 2D surface ("UV unwrapping") Project texture from scanned object to cylinder object ("texture baking")
Output	Format: JPEG Resolution: 5760 x 5760 In real world distances: 144 cm Size of a pixel: 0,25 mm
	Step 3: tracing and colour reconstruction
Software	Inkscape
Procedures	Tracing & reconstructing lines with "Bezier curve" tool Colour fill pattern *In total 3 alternative options were created*
	Step 4: export
Software	Inkscape/GIMP
Procedures	Inkscape: Export PNG, highest quality GIMP: convert PNG to JPG, highest quality (required by printer)
Output	JPEG files: 1488 x 7809 px 178 dpi

Table 3. Scan processing datasheet.

Photometric documentation post-processing details	
Software	Adobe Lightroom Classic
Procedures	Colour calibration using xrite colourchecker passport plugin White balance using colourchecker passport Export to tiff
Output	Tiff files: 6016 x 4016 px (same as raw)

Table 4. Photo processing datasheet.

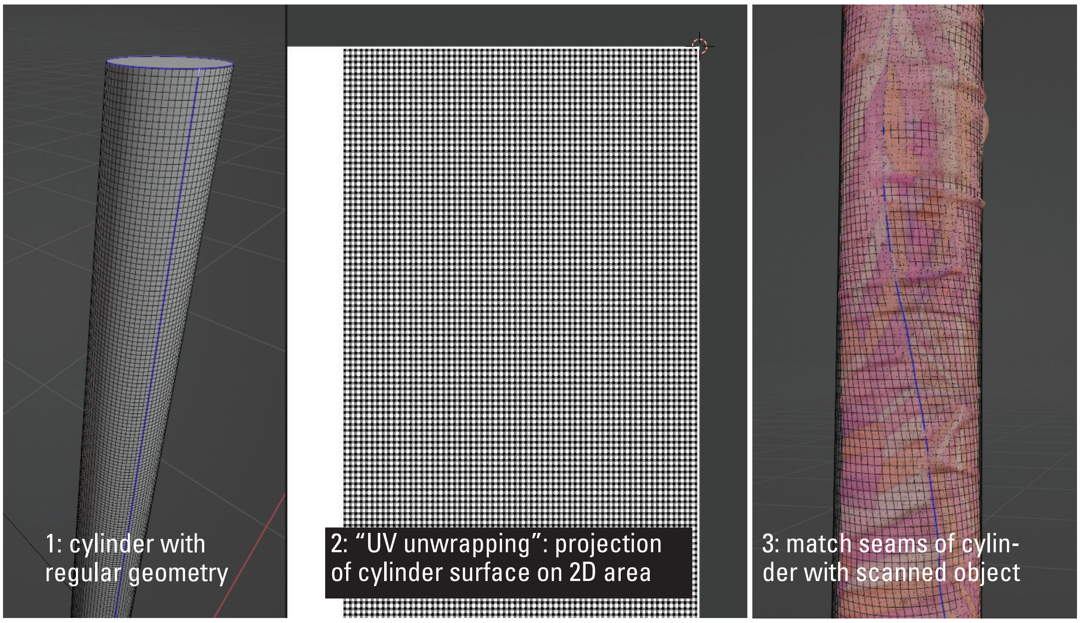

Figure 5. Steps to project the distorted cloth and pattern on a rectangular flat surface.

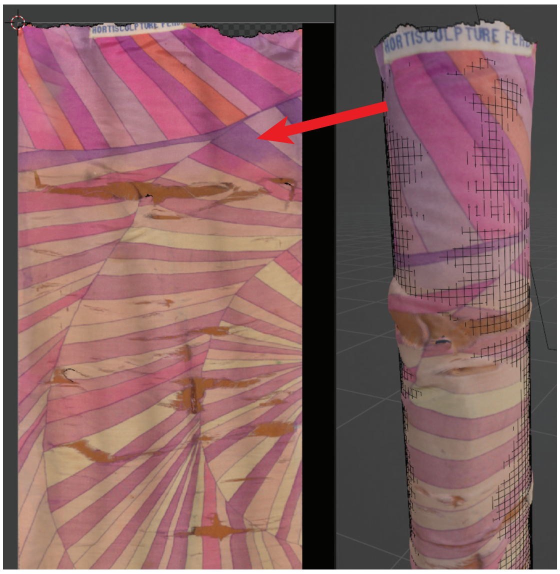

Figure 6. "Texture baking": back projection of pattern to regularised cylinder 2D space.

Figure 7. Bezier curve tool to trace bands in Inkscape.

The scan data was processed in Artec studio 12 resulting in a textured 3D mesh. The exported mesh was imported into Blender, the 3D modelling software. To be able to create a perfectly flat rectangular projection of the print, first a cylinder with regular geometry was drawn matching the object as closely as possible. Once the cylinder was aligned with the object, seam lines were assigned so that the texture could be UV-unwrapped along those lines, resulting in a rectangular 2D projection of the fabric (fig. 5 and 6). This allows us to edit the pattern in a flat environment.

This projection was then exported into Inkscape, an open-source graphics editor, so that it may be traced. Since the original fabric was wrinkled and bunched up in areas on the stem, the scanned projection does not show straight lines. Using the Bezier curve tool, curved and straight lines were traces over the perpendicular bands, producing a flat outline of the colour pattern (fig. 7).

This method of creating a flat projection made it possible to recreate the pattern without the distortion caused by the wrinkled fabric or cylindrical shape.

Once the outline of the pattern was completed, the faded colours had to be filled in by matching the colours from the photographs taken of the tentacles. Colour swatches were created from these photographs and the pattern was recreated on the projection. Twelve colours were identified in total by using manual visual identification, and these were verified both in colour accuracy and location by the restorers (fig. 8). The colour swatches were labelled as their RGBA codes (Table 5).

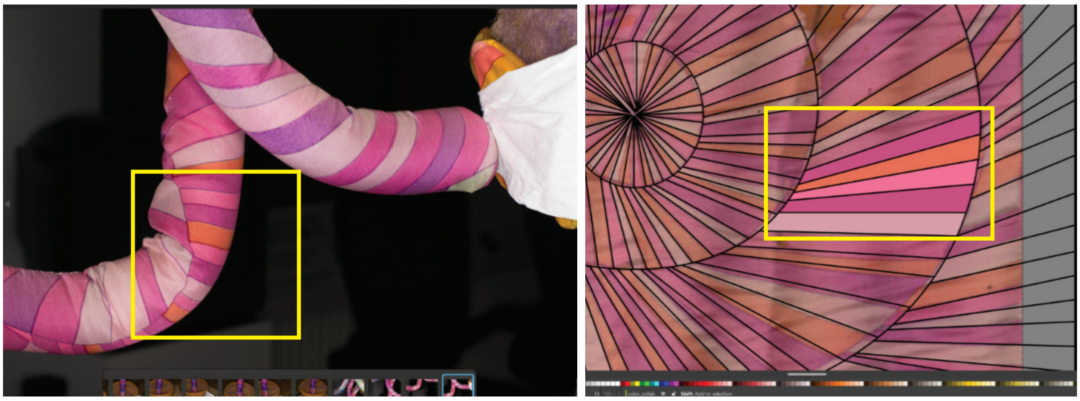

Figure 8. Colour pattern identified on photograph and copied onto scanned projection.

Reconstruction 1	Reconstruction 2, option 1	Reconstruction 2, option 2
#d495a0	#d39e87	#deab98
#c14778	#c7678d	#dc6599
#e3654e	#de814e	#fd7f3a
#ee678c	#da859a	#df8392
#c28dae	#c28dae	#c28dae
#793281	#793281	#793281
#9b3072	#9b3072	#9b3072
#26898c	#4a8b9f	#5598af

Table 5. RGB codes for different colour reconstructions.

Once the pattern was reconstructed, the fabric was projected back onto the original 3D scan to visualise how it will look once it is printed (fig. 9). The flattened projection of the scan is saved in PNG format and given to the restorers for printing (fig. 10).

The first printed result was compared to the original fabric, which showed the reconstruction was not entirely accurate. Thus, the colours were modified based on photos and subjective visual approximation by the restorers, resulting in two additional colour reconstructions. At the time of writing, these were not yet printed.

Figure 9. Virtual rendering of reconstructed pattern on scanned object.

Results

Discussion

The nature of this project involved a high degree of decision making. While the scanning process was relatively straightforward, potential error arose during the pattern reconstruction and colour matching stages.

While reconstructing the patterns on the stem, care was taken to follow the curvature of the original UV projection while taking in account the wrinkling of the fabric. The stem is made up of circular bands and within them, vertical bands of alternating colours. The circular bands do repeat throughout the stem; however, the vertical bands that make up the circular bands do not have a distinguishable colour pattern (fig. 10). For the reconstructed projection, we added margins to allow for room when sewing the seamline. These added margins included a continuation of the colour patterns, which had to be chosen based on the likelihood of the present pattern. This

Figure 10. Comparison of printed fabric with original (photo by Ellen Jansen).

presents potential error, as there is no certainty as to what the pattern is; however, this margin will not be visible once it is printed and sewn onto the stem.

The colour choices for the pattern also present a degree of subjectivity. The polarising lenses used during image capture of the tentacle patterns reduced the amount of external light; however, it does not eliminate it completely, and some areas may have experienced greater lighting than others. This can affect how the colours in the images are displayed, and since these images are used as colour samples for the stem restoration, it may ultimately result in the colour patterns being slightly unrealistic to the original. Once the reconstructed pattern was printed onto the fabric, the restorers compared the colour difference between the new fabric and the original colour that was still visible in the tentacles. Naturally, the colours varied somewhat between computer screen and printed fabric, and four colours were identified that required adjusting. Sitting down with the restorers to adjust the colours together, we changed the tone and brightness of the four colours, giving two more options for each colour variance to be printed again.

Dissemination

The results of this project are disseminated through this report, and a blogpost, both of which can be accessed on the 4D Research Lab website (https://4dresearchlab.nl). The processed files are handed over to the restorers and restorers for this project so that they may print out this reconstructed fabric and apply it to the *Shigiory Torbinata* at Bonnefanten Museum.

Figure 11. Original texture and three options of reconstructed colour patterns.

References

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