POLYCHROME SCULPTURE:
TOOL MARKS, CONSTRUCTION
TECHNIQUES, DECORATIVE PRACTICE
AND ARTISTIC TRADITION

Volume I & II Edited by Kate Seymour
Volume III Edited by Stefanie Litjens & Kate Seymour
POLYCHROME SCULPTURE: TOOL MARKS, CONSTRUCTION TECHNIQUES, DECORATIVE PRACTICE AND ARTISTIC TRADITION

Papers and Posters

Proceedings of three Interim Meetings of ICOM-CC Working Group Sculpture, Polychromy, and Architectural Decoration

Volume I: Maastricht, October 2010 ~ Hosted by SRAL, Maastricht
Volume II: Glasgow, April 2012 ~ Hosted by Glasgow Life, Glasgow
Volume III: Tomar, May 2013 ~ Hosted by Instituto Politécnico de Tomar, Tomar

Volume III: Stefanie Litjens & Kate Seymour (Editors)

Front Cover Photograph: Niklaus Weckmann, workshop (active in Ulm) St. George ca. 1510, limewood (tilia sp.), Suermondt-Ludwig-Museum, Aachen
Proceedings of three Interim Meetings of ICOM-CC Working Group *Sculpture, Polychromy, and Architectural Decoration*

**Polychrome Sculpture: Tool Marks and Construction Techniques**
(Maastricht, 2010)

**Polychrome Sculpture: Artistic Tradition and Construction Techniques**
(Glasgow, 2012)

**Polychrome Sculpture: Decorative Practice and Artistic Tradition**
(Tomar, 2013)

**Selection of papers:**
Kate Seymour: Coordinator ICOM-CC Working Group Sculpture, Polychromy, and Architectural Decoration (Maastricht, October 2010; Glasgow, April 2012; Tomar, May 2013)
Arnold Truyen: Assistant Coordinator ICOM-CC Working Group Sculpture, Polychromy, and Architectural Decoration (Maastricht, October 2010; Glasgow, April 2012)
Stephanie de Roemer: GlasgowLife, Burrell Collection, Glasgow, UK (Glasgow, 2012)
Ana Bidarra: Assistant Coordinator ICOM-CC Working Group Sculpture, Polychromy, and Architectural Decoration (Tomar, May 2013)

**Conference Organisation:**
*Maastricht 2010:*
Kate Seymour & Arnold Truyen
Assisted by: Siska Losse and Andrea Retrae

*Glasgow 2012:*
Kate Seymour & Stephanie de Roemer
Assisted by: Muriel King and Angel Puck

*Tomar 2013:*
Kate Seymour & Ana Bidarra
Assisted by: Merel Lantman, Claudia Falcao, João Coroado, Agnès Le Gac, Ricardo Triães, and Antonio Joao Cruz.

**Conference Hosts:**
*Maastricht 2010:*
Stichting Restauratie Atelier Limburg, Maastricht, The Netherlands

*Glasgow 2012:*
Burrell Collection, Glasgow Museums / Glasgow Life, Glasgow, UK

*Tomar 2013:*
Instituto Politécnico de Tomar, Tomar, Portugal

**Editors of the Proceedings:**
*Volume I & II.* Kate Seymour: Coordinator ICOM-CC Working Group Sculpture, Polychromy, and Architectural Decoration. With the help of Assistant Coordinators Clare Heard and Ana Bidarra.

Preface

‘Polychrome Sculpture: Tool Marks and Construction Techniques’ was the first of three Interim Meetings organised by the ICOM-CC Working Group Sculpture, Polychromy, and Architectural Decoration during the period 2010-2013 which focused on construction processes and decorative practice for polychrome sculptures. Papers given at the 2010 meeting covered the study of tool marks found on sculptures that relate to the construction process, whether these be related to the tools used to carve or mould the support or the periphery aids used by artisan carvers in their working practice, such as work benches or clamps. Registering, documenting and investigating the evidence of the working process can give insight into studio practice and if a large enough body of evidence is collected, may even provide tentative attribution to a specific studio or workshop. The meeting was hosted by the Stichting Restauratie Atelier Limburg (SRAL), in Maastricht and was attended by around 60 international specialists in the field of polychrome sculpture. Volume I of this compendium includes six of the nine papers and four of the five posters presented at the meeting.

The second meeting ‘Polychrome Sculpture: Artistic Tradition and Construction Techniques’ followed on in the theme outlined in 2010. This meeting was hosted at the Burrell Collection by Glasgow Life Museums, in Glasgow, UK in 2012. The two day symposium focused on artistic traditions within the field of polychrome sculpture. Papers were selected to follow on from themes touched upon in the preceding meeting in Maastricht, focusing on how artistic traditions influenced construction processes. Artistic practice from the Netherlands to Portugal, from the medieval to more modern times was outlined and links between different countries were emphasised. Seventeen papers and seven posters were presented during the meeting, of which twelve papers and six are published in Volume II of this compendium.

The third interim meeting Polychrome Sculpture: Decorative Practice and Artistic Tradition reviewed how decorative practice was linked to artistic tradition. Here seventeen papers and seventeen posters were presented, the majority of which are published in Volume III of this compendium. These focused on the surface effects created by artisans working on polychrome sculpture. Several decorative techniques have been addressed: painting techniques from different regions and epochs, gilding, estofado, use of incised and punched patterns, varnishes, lacquers, applications, and conservation methodology used to deal with challenging problems. Presentations showed that local practitioners are influenced by international taste and developments. The meeting was hosted and jointly organised by the Instituto Politecnico de Tomar (IPT) in Tomar Portugal.
Volume III

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Papers
Polychrome coatings on a lime plaster altarpiece (1571): the Gaspar Fragoso Chapel in Portalegre.

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Abstract
A considerable artistic heritage is found in the east central Portuguese region of Alentejo. Lime (or slaked lime) have always been a key construction material. In fact, its use throughout the centuries is the best testimony of the ancient decorative techniques, deep rooted in the Iberian peninsula. The versatility of lime when combined with different aggregates (sand, pigments, marble powder) enabled the successful development of different techniques that have remained to this day. Alentejo region is a perfect showcase concerning the lime's modus faciendi, including mural painting, sgraffito, lime and sand plasters or mortars, as well as whitewashed façades. In this paper the author highlights the altarpieces built with lime and sand plaster mixtures. These altarpieces represent an artistic typology, still very present in the northern Alentejo, and an important part of this region's identity.

Keywords: Altarpiece, lime plaster, mannerism, Alentejo.

The altarpiece of the Gaspar Fragoso chapel: forms and functions
The Gaspar Fragoso chapel, named in commemoration of its patron, is located in the convent church of Saint Francis, in Portalegre (Figure 1). The convent was built in the thirteenth century, and is one of the oldest in the city. The chapel was also the first to be established within the building, in the reign of King Dinis (1261-1325) [1]. In the second half of the sixteenth century the chapel became part of Gaspar Fragoso assets. This nobleman and a king’s knight remodelled the space as his sepulchral chapel. Fragoso is portrayed recumbent, lying on a white marble tomb, with his sword placed at his right side (Figure 2). In the sarcophagus an inscription gives account of the year of Fragoso’s death (1571), adding that he was responsible for the repair of the chapel, as well as for the making of the altarpiece.

Figure 1. Saint Francis convent in Portalegre, northern Alentejo, Portugal. © Patrícia Monteiro.
In 1943, the historian Luis Keil drew attention to this chapel, regretting its poor state of conservation [Keil 1943, 130]. His main interest lay in the primitive architectonic elements belonging to the initial building phase of the convent still present in the chapel. Further, the extraordinary altarpiece found in the same location caught his attention. Keil immediately described this as made of limestone. Trying to establish stylistic affiliations, Keil pointed to similar works of art in Coimbra. This city is well known for its strong tradition in limestone sculptures. Keil’s classification, based only on an empirical analysis, led however to subsequent misinterpretations of this artwork.

The Portalegre altarpiece covers the entire height of the back wall of the chapel, except for a small window at the top and the space occupied below by the altar bench, which was added in a later undetermined period (Figure 3). During the interventions undertaken by the conservation company *In Situ* (2008) the chapel was investigated thoroughly. Results lead to the conclusion that the sarcophagus was originally placed below the altar. It must be noted that the ground level in the chapel used to be lower, and that it was altered during a later remodelling of the church.

Figure 2. *Left*. Gaspar Fragoso’s altarpiece. © Patrícia Monteiro.
Figure 3. *Right*. Gaspar Fragoso’s tomb (1571). © Patrícia Monteiro.

The original combination of the two elements (altar and tomb) was indeed in accordance with the example of other tombs composed by recumbent statues and also associated with altarpieces. The most celebrated for its artistic quality is the marble altarpiece of Bishop D. Jorge de Melo (1519-1548) in the Saint Bernard’s convent (Portalegre), which is attributed to the French sculptor Nicholas of Chanterene (Figure 4). Keil notes that this master sculptor could be the author of the Portalegre tomb, since he was in Évora between 1535 and 1540, where he was involved in similar works [Keil 1943, 31]. Chanterene remained in Portugal for about three decades (1517-1551). His artistic solutions pleased the highest elite of the kingdom, which explains his success and influences on a national level [Grilo 2000, 15].

The investigation, carried out in 2008 during conservation work undertaken in the Gaspar Fragoso chapel, also concluded that the tomb was partially truncated to be better adapted to the space where it is today. It is unknown when the sarcophagus and the effigy were moved, but this alteration may be related with a liturgical change in the chapel.
In accordance with the first mannerist Portuguese altarpieces, the Gaspar Fragoso chapel consists of a two-dimensional structure constructed with wide straight lines. Rectangular panels are used to construct the three levels. These panels are vertically interspersed with protruding pilasters and friezes decorated with grotesques and cherubs. The figures, arranged along the altar, have a realistic modelling of volumes. The surface has been repeatedly whitewashed throughout the centuries. The iconography follows the typical canons of the sixteenth-century religious programs, depicting some of the Catholic church main figures. Starting from the top of the altarpiece, God is represented, presiding over the whole composition. A panel depicting the Pietà is centrally placed in the second level, flanked by panels showing the Virgin Mary (left) and the Angel Gabriel (right). Although the two figures are represented separately, together they form the scene of the Annunciation. Thus, at the centre of the altar, and in both representations, the first and last episodes of Christ’s earthly life are shown. The third and final level shows two Doctors of the Church: Saint Augustine with his mitre and crosier (left) and Saint Jerome, depicted as a penitent in the desert (right) (Figure 5). At the centre, a bizarre figure is visible. It is a frown or mask, a common element frequently present in mannerist decorations (Figure 6). At the bases of the two central pillars are the busts of Saint Peter and Saint Paul, as cornerstones of the eastern and western Catholic church.

This iconographic depiction follows, without surprises, the standards imposed by the Counter-Reformation. Concerning its materiality, however, some startling discoveries were made. In 2008, the conservation team found out that the altarpiece was not made of limestone, but that it was built in a mouldable paste using slacked lime and coarse sand as its main components, applied onto a brick structure. Further analysis of the materials was not carried out. The moulded figures seem to have been modelled directly in-situ on the wall. A thinner layer of plaster containing a finer sand aggregate was subsequently applied as a finish layer. Sometimes other additives were present in this final coating such as marble flour and gypsum [Proudfoot 2001]. But these materials were not confirmed in this case. This layer was then painted or gilded. In other altarpieces, dating from late eighteenth century, a final polish might also been added to the final layer, in order to increase the brightness of the stone.
During the conservation campaign a date on one of the pilasters was discovered: 1571. The discovery of the date, coinciding with the death of the founder, corroborated the information that Gaspar Fragoso ordered the repair of the chapel and the construction of the altar therein.

Evidence of at least two polychrome coatings were found in several areas [2]. Successive whitewash and interventions undertaken in unknown periods, contributed to the distortion of the primitive forms of this altarpiece. At the same time, the underlying polychrome layers have almost completely vanished leaving only traces of what would be its original decorations. It would be of great interest to perform analyses on the materials used in this altar, namely the pigments and binding media, in order to characterise this artwork from a technical point of view.

It is common knowledge that the real limestone altarpieces were also painted and gilded, despite of the fact that most of these coatings were removed in the twentieth century during restoration campaigns. The similarities between the Gaspar Fragoso altarpiece and the Coimbra limestone examples highlight the strong versatility of lime plaster and its capability to emulate other artistic techniques [Teixeira and Belém 1998].

The influences of the renaissance limestone altarpieces

The unusual appearance of the Gaspar Fragoso altarpiece led to the belief (defended by several authors) that Coimbra’s limestone works were most likely to be the inspirational artistic models [Pereira and Rodrigues 1986]. In fact, such a comparison only increases the illusory potential of lime plaster works over the centuries.

Among the works of art that combine a tomb with altarpieces or with sculptural structures are the examples made in 1522 by Nicholas of Chanterene in the church of the Monastery of the Holy Cross (Coimbra), with the statues of King Afonso Henriques and Sancho I [Grilo 2000, 424]. In the same city there are still other examples, such as the knight João da Silva (1559) by the sculptor Jean de Rouen in the Saint Marcus church, or the late renaissance altarpiece in a lateral chapel of the church Espinhal [Macedo and Serrão 1996, 349].

Figure 5. Left, Saint Jerome. Gaspar Fragoso’s altarpiece (detail). © Patrícia Monteiro.
Figure 6. Right, Mask (grotesche, detail). © Patrícia Monteiro.
There are obvious differences in the concept and ornamentation when comparing the tomb of Gaspar Fragoso with that of royal and ecclesiastical tombs. Nevertheless, there is an undeniable connection between these different types, and this lies in its evocative function. With different materials and different levels of erudition, these tombs all share the same purpose: to dignify the memory of their patron for eternity. The Gaspar Fragoso altarpiece, associated with his tomb, is part of this enhancement logic, by demonstrating the piety of the deceased and ensuring, at the same time, the salvation of his soul.

Regarding polychrome coatings on limestone altarpieces, there are still today in Coimbra some examples from the sixteenth century that show this tradition. An example is the altar of Tobias and the Angel (Machado de Castro Museum). It is also possible to find similar cases in other locations: the altarpiece of the Holy Ghost chapel in Travanc (attributed to the sculptor Jean de Rouen and made in the beginning of the sixteenth century), the altarpiece of the White Saints chapel in the church of Our Lady of Maceira in Leiria (1570), the altarpiece of the Holy House of Mercy in Tentúgal by Tomé the Elder (1595 - 1596) and the altarpieces of the churches of Saint John the Baptist and Saint Vincent, both in Abrantes (late sixteenth century), whose artists involved in its construction were original from Tomar [Gomes 1996, 269] [Dias 1996, 27] [Cardoso 2008, 50-61] (Figures 7 and 8). The possibility of finding similar altarpieces in Spain (namely in the Extremadura region) should not be excluded, given the artistic heritage shared by these two countries [Gárate Rojas 1994]. This possibility awaits further investigation.

Lime plaster altarpieces from the baroque period

Works on lime, sand plasters and mortars (with and without polychrome finishes) are quite popular in northern Alentejo. Even today the presence of these works is very visible, either in outdoor decorations (windows, doors, frames and corners) or used in the reproduction of architectural and sculptural elements (columns, chapters, arches, statues).
Taking into account the current state of research, the Gaspar Fragoso altarpiece appears as a single example of the mannerist period, the starting point of a tradition firmly established in the region. In the eighteenth century, the number of works created using this technique increased considerably, with altarpieces like those which can be found in the Saint Catherine’s chapel (Portalegre Cathedral), the church of Our Lady of Conception (Monforte) or even the old convent church of Our Lady of Conception (Olivenza, Spain). The latter, dating from the early eighteenth century, is actually one of the most impressive examples, not only for its size, but also because of the quality of its pictorial coatings, which simulate with great effectiveness marble.

The number and range of cases with polychrome or gilded finishes, demonstrate two realities: namely the growing interests of the clientele for this kind of construction on the one hand; and the existence of specialised artists to build them on the other hand. These artists very likely worked in partnership. The masons or sculptors built the altar, while the finishing coatings were applied by painters. The painter’s intervention would take place at the end of the construction phase, covering the altar with gold or stone (especially marble) imitation.

The archival documents, studied during the author’s PhD-research, gave no information about authorship or dates, nor about the manner of building this type of altarpieces [Monteiro 2013]. Nevertheless, amongst the extensive documentation gathered, several partnerships between artists were discovered. For example, in 1681, the painter António Soeiro da Silva and the sculptor André Ferreira worked in the main altar of the church of Saint John the Baptist, in Castelo de Vide. António Soeiro was supposed to paint the altar and gild the columns ‘(...) of false stones (...)’ [3]. Another case was the contract signed in 1748 by the Portalegre gilder José da Silva for the main altar of the Third Order church in Monforte. Here the details involving the hand labour were even higher. The altarpiece of the church had to be gilded ‘(...) and false stone with the colour of mother pearl (...)’ should be applied, suggesting preferential treatment given to certain materials in the valuation of the final work [4].

Figure 8. Annunciation (detail). © Joana Balsa de Pinho.
In the second half of the eighteenth century, the applied colours of these altarpieces became more diverse but, at the same time, less realistic. An increasing decorative taste was also present, with flowers and naturalistic motifs made of stucco reliefs, attached to the altars and then painted. Simpler decorative techniques were used to create the marbled compositions, allowing the artist to work rapidly but with less perfect results. One of those techniques was, for example, the use of a sponge in order to emulate stone covering of the altar columns. At the same time, decoration motifs were repeated through the altar’s surface using a stencil transfer technique [Weyer 2015, 140]. This technique became very popular in the nineteenth century, because it allowed the systematic reproduction of ornamental motifs with paint through a model made of a semi rigid material.

**Conclusion**

The large number of seventeenth and eighteenth-century altarpieces, scattered somewhat throughout the Alentejo, constitute a very heterogeneous group. There is little stylistic conformity and, in the majority of cases, the artists involved in their creation are unknown. Despite this, the illusory potential of the mouldable mixtures, which were used in their construction in order to resemble other materials (like limestone or marble), remains until today their most striking common characteristic. In this context, the earlier Gaspar Fragoso altarpiece appears as a completely unique case, of artistic and historical relevance in northern Alentejo. Further knowledge of this specific decorative technique will only be possible with more interdisciplinary studies carried out by art historians and conservators, supported by chemical analyses of the materials that can support new interpretations.

**Acknowledgements**

The author wishes to thank the Foundation for Science and Technology (FCT) for all the support given throughout this PhD. investigation and to the Robinson Foundation (Portalegre) for allowing the access to the Saint Francis convent. A special thanks also to the conservators of the company *In Situ* for all the information’s related with the intervention on the Gaspar Fragoso chapel.

**Endnotes**


2. According to the conservation report, these coatings are subsequent to the execution of the altarpiece. For more detailed information please consult the final report presented by *In Situ*, Conservation of Cultural Assets *Igreja de S. Francisco de Portalegre, Valorização e estabilização do retábulo em massa da Capela Gaspar Fragoso* (May 2011).

3. District Archive of Portalegre, *Cartórios Notariais de Castelo de Vide*, Contract between the painter António Soeiro da Silva and the sculptor André Ferreira for the gilded altarpiece of the Saint John the Baptist church in Castelo de Vide, CNCVD01/001, Cx. 19, Liv. 70, 2 September 1681, ff. 40-41v.

4. District Archive of Portalegre, *Cartórios Notariais de Monforte*, Contract between the Fellowship of the Third Order, in Monforte, and the gilder José da Silva, for the main altar of their church, CNMFT02/001/Cx 9, Liv. 13, 29 October 1748, ff. 96v.-98.

**References**


Please use the following when citing this paper:

The role of stone substrate in the stability of oil paint films. An insight into some issues influencing durability and conservation.

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Abstract
In this research, the polychromy of two Spanish stone sculptures dating from the beginning of the fifteenth century is studied and the factors influencing their unusual stability are discussed. Despite being created in a very well founded empirical way, the cohesion, adhesion and moisture sensitivity of such paint films changed in time as a consequence of many chemical-physical reactions, that influenced their stability and aesthetic appearance. From this perspective, it would be fair to think that any attempt of consolidating these composite structures or of eliminating the soils and other substances deposited on their surface might have consequences that could affect not only their visual appearance but also the material integrity of the paint film, its flexibility, solubility and adhesion to the stone. Conservators-restorers usually focus their attention on degradation and failure issues. However, common treatments such as consolidating or cleaning these paint films demand a previous understanding of what made them survive in such a pristine condition, this is, an understanding of the issues governing their stability. When such mechanisms have not been understood properly in terms of how do they affect the properties of the paint film, conservation treatments cannot be adjusted to such changes and might interfere in the performance of these composite systems, compromising their stability in the mid-to-long term. It is for this reason that a multiple joint approach, that takes into consideration art history, physics, chemistry, art technology and conservation, is required to set the state of the art and to understand how such durable polychrome layers were created.

Keywords: Burgundian sculpture, polychrome stone sculpture, oil paint films, metal soap, oxalate polychromy conservation.

Introduction
The changes experienced by oil paint films during ageing differ as a function of the composition of the underlying substrate and can explain both the failure and the durability of any polychromy. When lying on stone the changing environmental conditions but also the specific nature of the materials and techniques selected for carving and coating the sculptures determine the physical-chemical properties and behaviour of the paint film at the moment of creating the artwork, during its ageing as well as after any conservation treatment. Understanding the properties of such paint films, their adhesive and cohesive forces and their solubility as a result of changes in their composition is not easy. It is for this reason that when designing any conservation strategy which involves the use of any aqueous method, monitoring surface pH and conductivity as well as understanding solubility issues and the adhesion forces existing between soils, the paint layer and the stone substrate are needed to minimise risks and preserve the balance acquired by the artwork after ageing [Wolbers 2000] [Wolbers 2014].

The initial part of this research consisted of an historical investigation that provided a deeper understanding about how style and technical solutions of Burgundian polychrome stone sculptures developed in Spain (1417-1422), as a result of the arrival of some Sluter and Malouel partners in the fifteenth century. After a detailed study, it is evident that the technical solutions...
adopted in the two, Spanish, mediaeval polychrome stone sculptures presented here, contributed to the exceptional condition they present nowadays. It can be suggested that, far from a dramatic decay, the complex balance acquired over time between the oil paint film and some accurately chosen inorganic substrates could be responsible for their unexpected survival. This evidences that not only Malouel and Sluter where in Burgundy, but also the teams that created these two case studies in Spain, faced problems related to creating stone sculptures with paint from an empirical but very well founded and experienced viewpoint [Nash 2010] [Aguado-Guardiola et al. 2014]. As it happens in Burgundy, the extraordinary condition they present seems to be the combined result of the lithotype choice, the treatment of the stone surfaces and the accurate selection and application technique of the painting materials. As far as it seems, the artists could have even counted on the expected negative effects that the environmental conditions could cause in time on the painted surfaces they were creating (Figure 1) [Aguado-Guardiola et al. 2014].

![Figure 1. The Well of Moses (The Great Cross), 1395-1406 Chartreuse de Champmol, Dijon (France). © Elena Aguado-Guardiola.](image)

**Case studies. Naturalism and durability issues in polychromies on stone sculpture**

In the production of masterpieces, innovation in art technology has usually been part of the creation process. Talent was not enough and artists were used to learn from past and present knowledge to create something new and improved. The application of a paint coating on a stone sculpture has been challenging throughout history. During the last centuries, social, economic, cultural, biological, chemical and physical factors have been powerful enemies that usually won the battle against artists’ wish of ensuring the survival of the painted surfaces they created on...
stone. This is the reason why very few stone sculptures conserve their original polychromy nowadays.

The Tomb of Chancellor Villaespesa in the cathedral of Tudela (Spain) and the Altarpiece of the Chapel of Los Corporales in the church of Santa María in Daroca (Spain) were carved in sandstone and limestone respectively and painted at the beginning of the fifteenth century. The craftsmen who created these works were trained, directly or indirectly, in the typical, new, Burgundian style of the workshops of Claus Sluter and the painter Jean Malouel at the Chartreuse de Champmol, near Dijon (France), in circa 1396-1405. These stone workers and painters brought to Spain, not only the new Burgundian style, but also some techniques for carving and painting stone sculptures. Their technical knowledge was adapted to the materials available in Navarra and Aragon and to the local Spanish art technology tradition.

![Figure 2. Left: St. Clare. The Chapel of Los Corporales, 1417-1421. Church of St. Mary, Daroca (Spain). Right: FTIR results of the ground and upper layers of a cross-section removed from the figure. © José Coarasa-Barbey.](image)

Just twelve years after The Great Cross of Champmol was finished by Sluter and Malouel, the master builder Isambart created the Altarpiece of the Los Corporales Chapel in Daroca. He worked together with Hennequin of Bruxelles, who had also worked with Sluter at Champmol, as well as with Perrin Jalopa, who was a French master builder that had worked in Navarra with Jehan Lome (Sluter's colleague at Champmol). Pere Johan (named Perrinet yimaginador in the Libro de Fábrica de la Seo from 26th July 1418) was a very young Catalanian sculptor who had learned the new Burgundian style and techniques in Barcelona while working with Francesc Marata (a former partner of Sluter). Pere Johan was probably the master sculptor of Los Corporales Chapel [Aguado-Guardiola et al. 2014].

It seems likely that Hennequin of Bruxelles, Perrin Jalopa and Pere Johan, together with master builder Martín de Retuerta, created the Tomb of Chancellor Villaespesa in Tudela, since their names appear in the chancellor's will [Aguado-Guardiola et al. 2012].
The request of the clients to have devotional relics, as well as their credible and realistic portraits carved in stone and well painted could have brought artists to create a new artistic language to assume a double challenge, namely naturalism and durability. The materials and techniques chosen by sculptors and painters had to face such a challenge. Their mission was not easy at all, but they managed to execute it successfully thanks to the implementation and diffusion of the solutions devised by Claus Sluter and Jean Malouel around 1400.

The accurate choice of materials. The stone

Being highly suitable for a detailed and naturalistic work, limestone from the subterranean quarries of Asnières was selected by Claus Sluter for carving the sculptures of the Great cross. Due to its high absorption index, the paint medium would be quickly absorbed into the porous structure, although with a limited degree of penetration, thus creating a chemically and mechanically underbound paint film. Due to this, Sluter used the Is-sur-Tille stone to make the base of the pillar of the Great Cross. The Is-sur-Tille stone is a white limestone without iron impurities and cemented with calcite. It is a much less porous and stronger stone for structural work than the Asnières one and was selected to act as a barrier against the extremely wet ground surrounding the Great Cross [Nash 2013][Mertz 2004, 45]. The selection of this material resulted in the minimisation of capillarity problems and saline weathering for the sculptures on top.

In Aragon, the lithotype selected for the altarpiece of the Los Corporales Chapel was a soft white miocone micritic limestone from the stone quarry of Villanueva de Huerva, with similar properties to Asnières stone. Its softness and the homogeneity of its aggregated small grains favoured a much easier detailed and naturalistic carving work. The high porosity, as well as the composition of this stone also enabled the absorption and proper adhesion of the paint layers.
and its white colour provided a characteristic luminosity to the sculpture. Scanning Electron Microscopy-Energy Dispersive X-Ray Spectroscopy (SEM-EDX) and X-Ray Fluorescence (XRF) analyses have revealed the presence of a large amount of calcium carbonate and a small quantity of magnesium and silica (Figure 2).

On the other hand, the stoneworkers and sculptors of the Tomb of Chancellor Villaespesa in Navarra also used a tertiary sandstone with a high proportion of quartz and a high percentage of carbonated minerals. It is brown-reddish stone, extracted from the Pitillas stone quarries and harder than the limestones from Asnières and Villanueva de Huerva. This fact explains why, in spite of the small and homogenous size of its grain, such a detailed and meticulous naturalistic carving was not possible in the stone from Pitillas. Its porosity leads to a slower absorption of the paint binder but has a greater penetration index than the previously mentioned limestones. This would have conditioned the selection of the procedures and materials chosen to paint the sculptures. In addition, its dark brown tone conferred a different chromatic and visual effect to that of the white limestones. Perhaps for this reasons a coating of linseed oil mixed with lead white was applied to the Pitillas stone in an attempt not only to reduce the penetration of the binder but also to make it resemble white limestone. [Aguado-Guardiola et al. 2014].

The stone-paint film interface

The border between the stone and the paint layers can be understood as an interface, since not always it implies an interruption between layers of different nature. It can actually turn into a new physical space where some physical-chemical interactions between the constituent materials of the support and the paint film are generated, giving rise to new intermediate layers with diverse composition and properties.

One of the techniques used by Sluter and his assistants in Champmol to improve the stone-paint interface layer was to scratch the surface of the limestone with very small tooth chisels. Tooth chisels were used to enhance the absorption of the oil by increasing the surface area. They were also used to create textures, which could help retain the right amount of oil paint on the stone, and to increase the adhesion, especially in the areas where they could present some slippery tendency, due to the effect of gravity (Figure 3).

After having been preserved in an unusual good condition for six centuries, it is obvious that chiselling the surface of the limestone contributed to the considerable durability of paint coatings on stone. Despite the use of such precise and small size chisels were not common in Navarra and Aragon at the beginning of the fifteenth century, a detailed study of the surface of the Tomb of Villaespesa, of the Chapel of Los Corporales in Daroca and of all the works later undertaken by these artists in Spain, has revealed the use of the same Burgundian scratching technique with little tooth chisels on the surface of the sculptures [Aguado-Guardiola et al. 2014].

The painting materials

The analytical report of the Great Cross of Champmol evidenced that Malouel basically used walnut oil as binding medium. Analyses also detected the presence of vermilion, ochre, massicot, chalk, lead white, red lead, ultramarine blue and azurite. Furthermore, some surviving documents refer to the purchase of orpiment, verdigris and red lacquer [Nash 2010, 122-123]. In the Great Cross Malouel made applied motifs with a filling of wax and lead pigments covered with a tin sheet [Nash 2010, 117-118, 137-141]. This moulding technique was used to form suns that decorate the clothes of some of the figures. In a similar way, stars made with the applied motifs technique are also found, covering the indigo film in the vault of the Tomb of Chancellor Villaespesa.

Light Microscopy, Fourier Transform Infrared Spectroscopy (FTIR-ATR), X-Ray Diffraction (XRD), XRF, Gas Chromatography-Mass Spectrometry (GC-MS), and SEM-EDX analyses have been carried out to characterise the two Spanish case studies. Samples from the Tomb of Chancellor
Villaespesa evidenced the presence of linseed oil, but also of glue in the binding medium in some areas. Ochre, red earth, lead white, minium, verdigris, vermilion, red lack, bone black, ultramarine blue and indigo have been identified in the paint layers [Artelan 2006]. In the altarpiece of the Chapel of Los Corporales of Daroca, the presence of linseed oil was also found as binding medium. The pigments and fillers identified in Daroca include ochre, red earth, lead white, minium, massicot, bone black and vermilion. All paints analysed are bound with linseed oil (Figure 3) [Parra 2012].

The presence of lead pigments in the layers in contact with the stone suggests that the artists had an empirical knowledge about the effect of lead ions in the fast, dry-to-the-touch drying of the oil. As suggested by Tumosa, lead is not particularly powerful as an oxidation assistant, but it contributes to the polymerisation and stabilisation of the paint film since lead compounds form ionomers by reaction with the oil medium [Tumosa and Mecklenburg 2005, 45] [Tumosa et al. 2005]. Lead pigments in the film prevent excessive absorption of the binder by the stone and enable the film to bond well to the porous substrate especially when its calcium ions could act as auxiliary siccative when dissolved by the increasing acidity of the oil. Together with other aesthetic reasons, this could explain the presence of lead white in the ground applied on the carbonated stone (Figure 4).

![Figure 4. Left. The Tomb of Chancellor Villaespesa, 1418-1422, Cathedral of Tudela (Spain). Right. Cross-sections showing stratigraphic layers. © Gobierno de Navarra. Institución Príncipe de Viana.](image-url)

**The role of stone substrate in the stability of oil paint films. The changing composition of a dynamic system and the new properties involved**

Being a porous system, stone substrates promote the migration of ions in aqueous solutions through its porous network and towards the paint film [Arnold 1990]. At the same time, stone materials hold moisture and water that can catalyse some specific reactions in the paint film and promote specific microorganism growth. In addition, temperature changes that could take place at the interface between this inorganic substrates and the paint film can be influenced by the
higher thermal inertia of stone. Finally, each lithotype presents a specific combination of minerals that could act as driers but also as inhibitors or retardants of some reactions when oil paint films age on them. Preliminary results of this research have evidenced that the behaviour of oil films on stone substrates differs greatly from one lythotipe to another, giving rise to multiple chemical and physical phenomena which are usually difficult to anticipate and that can contribute to modify the pH and conductivity of the paint film (Figure 5).

The specialised literature describes some models of the mechanisms involved in the metal soap formation, migration and aggregation inside the oil paint composite structure, and describe how stable ionomers can be formed when specific ions, that are present in the pigments, in the inorganic substrates or even in the environment, interact with the drying oils during ageing [Boon 2006][Burnstock et al. 2014, 7]. All these interactions govern the stability and cohesion forces of the paint film, as well as the occurrence of new interfaces with new composition, thus enhancing or weakening the chemical and mechanical adhesion to the porous substrate [Ferreira et al. 2011] [Duffy et al. 2014][Aguado-Guardiola et al. 2014].

These new balances respond to diverse mechanisms and reaction rates. As a result, the film-forming materials applied on stone by artists undergo degradation as a consequence of a combination of processes such as oxidation (with the formation of more acid and polar products), hydrolysis (with the consequent depolymerisation and formation of more acid compounds, promoting some basic mineral ionisation), polymerisation (with the formation of products of greater molecular weight), and saponification or salt formation [Mills and White 1990]. Some of the consequences for the paint film at a macroscopic level could be colour saturation, increased stiffness, as well as changes in their adhesive and cohesive properties.

Carbonates present in the two lithotypes of the case studies presented in this paper act as a ‘reserve’ of Ca$^{2+}$ and Mg$^{2+}$ ions in acidic conditions (2<pH<4.7), but also CaOH$^{-}$ and MgOH$^{-}$ ions in basic conditions (6.7<pH<13). These conditions contribute to increase the stability and the siccative properties of the lead ions in the oil paint film at the interface film/porous substrate (i.e. minimum and lead white). Besides, since calcium and magnesium carbonates were usually kneaded with the binder and pigments by the artist’s brush while painting, calcium and magnesium ions can be present in the paint film, being responsible for the adhesion at the interface, as well as for some specific drying properties of the bulk and the surface of the oil paint film [Osmond et al. 2005].

Calcium oxalates have been found in the polychromy of the two Spanish case studies presented here. Atmospheric chemistry can help explain the mineralisation or formation of new organic, inorganic and metal salts of mixed nature. In polychrome stone sculptures, oil paint films containing not only drying oil, and pigment but also variable amounts of colophony resin from solvents used by the artist, can interact with the materials present in the stone but also with the pollutants present in the atmosphere, seeking new chemical equilibria and generating new materials of different composition and properties such as calcium and other metal oxalates [Casadio et al. 2013].

Catalysts as UV radiation, high HR levels and thermal gradients can also enhance reactions in film-forming materials. Atmospheric pollutants are an important source of oxalic acid and oxalate. The dicarboxylic acids and related compounds in atmospheric pollutants are derived from primary sources, such as wood, coal, candles, oil burning or fossil fuel combustion, and secondarily produced from different precursor species via photochemical reactions.

Recently, the oxidation of isoprene and other biogenic VOCs has been proposed as an important source of oxalic acid. [Mkoma and Kawamura 2012, 256]. As a major identified water-soluble organic compound in atmospheric particulates, oxalic acid can reduce the surface tension of wet pollution particles. Being an acid compound (pK1=1.2), oxalic acid (as a major diacid species identified in atmospheric pollutants) and oxalate can form complexes with metals [Kawamura and Usukura 1993, 281], contributing to the dissolution of some minerals, such as calcium.
carbonate (CaCO$_3$), but also to the formation of some organo-metal complexes in the presence of moisture.

Some substances present in the stone and the paint layers can promote the chemical processes that lead lichens to decompose lithic constituents and some mineral pigments. Phenomena of high local intensity promoted by lichens include the excretion of low molecular weight organic carboxylic acids, such as oxalic, citric, gluconic and lactic acids, with combined chelating and acid properties, as well as the production of slightly water soluble polyphenolic compounds called ‘lichen acids’. These are able to form complexes with the metal cations, which are present both in the rock-forming minerals and in the pigments of the study-cases [Adamo and Violante 2000, 230].

Fungi also play a relevant role in some biogeochemical processes and can be a source of oxalic and other organic acids, causing not only the dissolution of minerals in the stone and the paint film but also the formation of salts such as oxalates and other mineral by-products [Jarosz-Wilkolazka and Gadd 2003, 541]. Lead and other metal chlorides have also been found in the polychromy of the two Spanish case studies presented here. Lead white could be the source of chlorine [1]. Analysis of protrusions found in Rembrandt’s *Lesson of Anatomy* identified not only lead carboxylates but also lead hydroxychloride [Heerem et al. 1999, 231].

Some ancient texts mention the presence of dung in lead white recipes [Carlyle and Witlox 2007]. The use of dung, as a source of chlorine, could also explain why high percentages of chlorine and chlorine compounds (calcium, potassium and lead chloride) have been found in the white lead paint layers in the case-studies [Castillo-Fonseca 2013]. Chlorine may promote the formation of more or less soluble lead chlorides in the paint film, but it can also contribute to the

![Figure 5. Oil paint film could generate different degradation products when in contact with mineral assemblages. The study of the NEW composition and properties of the painted system to be treated is a mandatory preliminary step to design appropriate conservation strategies. © The Authors.](image)
degradation of some minerals in specific lithotypes, such as carbonates and silicates [2] [Gettens et al. 1967, 125, 128] [Winter 1981, 96].

Conclusions

This research was intended to understand to what extent the creators of the case studies presented in this paper were aware, at least empirically, of the consequences of choosing one binder or pigment instead of another when coating a specific type of stone substrate.

There are a number of factors influencing the stability of paint films. The specialised literature refers to the study of the paint film itself and how adjacent layers, such as the ground layer, and the environment can play a role in their degradation. Some researchers have described models for the mechanisms involved in the metal soap formation, migration and aggregation processes inside the structure of the oil paint. They also describe how stable ionomers can be formed when specific ions, which are present in the pigments, in the inorganic substrates or even in their environment, interact with the drying oils during ageing. All these interactions govern the solubility, stability and cohesion forces of these paint films, as well as the occurrence of new interfaces with new compositions that tend to increase or decrease the chemical and mechanical adhesion to the stone substrate.

Recent in-depth studies have considered the implications of the presence of certain binders, fillers and pigments in the mechanical and dimensional properties of paint films, as well as the effects that certain environmental factors, such as temperature and moisture, can have in these properties. [Mecklenburg and Fuster-López 2006, 49] [Akerlund 2013] [Sawicka et al. 2014]. Nevertheless, little attention seems to have been given to understand the role of the underlying substrate in the properties and behaviour of the resulting paint film as a complex, open and dynamic system. Oil-polychrome-stone sculptures consist of an oil paint mixture applied on an inorganic porous substrate, which is usually subjected to ion leaching and migration mechanisms of aqueous solutions. As a result of such processes, the by-products formed in the oil paint film and at the interface existing between it and the inorganic substrate influence not only the pH, conductivity and water solubility of the resulting paint film, but also its cohesion and adhesion forces. This represents an extreme complexity in day-to-day conservation practice.

Metal soap aggregates or salt rich surface layers can present substantial challenges for the visual interpretation of paint films, the accurate scientific characterisation of the original materials and their properties, and the development of appropriate and effective conservation strategies. [Sutherland et al. 2013, 85] [Burnstock and Van den Burg 2014]. The conservation of these materials should involve the development of specific conservation protocols that appreciate the complexity of their technical solutions and the changing material properties over time. They should also take in consideration the physical-chemical balances that those materials, carefully chosen by artists, have reached in the context of the artwork over time as well as the identification of the potential risks posed by conservation materials and methods to the constituent materials.

Acknowledgements

This study was carried out as part of the research project HAR2016-75131-P granted by the Ministerio de Economía, Industria y Competitividad (MICINN) - Programa Estatal de Programa Estatal de Fomento de la Investigación Científica y Técnica de Excelencia, Subprograma Estatal de Generacion del Conocimiento.

The authors would like to express their gratitude to Alicia Ancho, the Andrew W. Mellon Foundation and Fundación Barrié, for their contribution to the development of this research. Sara Mohamed, Paolo Cremonesi, Xavier Mas and Dolores Julia Yusá are also acknowledged for their suggestions. Valeriano Jaurreta, Escuela Superior de Conservación y Restauración de Bienes Culturales de Aragón, Enrique Parra, HISPANAGAR, Olmusa S.L., Agaragar Productos de Conservación y Restauración are equally acknowledged for their contribution to this research.
Endnotes
1. Jaap Boon, personal communication.

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Please use the following when citing this paper:
Study and conservation of a polychrome terracotta sculpture from the Casa-Museu José Régio Collection. A first step towards the characterisation of the Barros de Portalegre sculptures.

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Abstract  
The polychrome terracotta sculpture presented in this paper represents the *Ecce Homo*. The artwork belongs to the ‘Casa-Museu José Régio’ (CMJR) collection. This collection consists of a great variety of objects, most of them from religious and folk art, that José Régio, a known Portuguese writer, gathered while living and working as a professor in Portalegre (Portugal), from 1928 to 1967. The material and technical study of this artwork, as well as the conservation and restoration treatments, took place in collaboration with the Polytechnic Institute of Tomar (IPT), the José Régio House Museum and the Conservation and Restoration Laboratory (Department of Chemical Engineering and Materials) of the University of Cagliari, Italy (DIMCM). The study and conservation treatment aimed to create the basis for the characterisation of the terracotta religious sculptures known as ‘Barros de Portalegre’, in which the *Ecce Homo* is included.

Keywords: Polychrome sculpture, terracotta, Barros de Portalegre, analysis, pigments.

Introduction  
The polychrome terracotta sculpture, representing the *Ecce Homo*, also known as *Barros de Portalegre*, belongs to the Casa-Museu José Régio collection (Figure1). This collection was owned by the Portuguese writer José Régio, gathered while living and working as a professor in Portalegre (Portugal), from 1929 to 1962 [Pires 2001, 31].

Studies made so far have only taken into consideration an aesthetic and stylistic characterisation. There are no physical or chemical studies about these particular regional productions. The designation ‘*Barros de Portalegre*’ was firstly used in 1962, in an art exhibition that took place in Évora [Patrão 2001, 39]. The theme for this exhibition was the Alentejo ceramics and its origins, evolution, styles, typologies and, in particular, the production from Estremoz and Portalegre. Concerning the Portalegre’s terracotta, it is not clear how these artworks were created, modelled...
and decorated. The fact that such sculptures only appear in Portalegre, or in the vicinity of the city, makes the authors believe that there was a local production, either in small workshops or in the several convents or monasteries that existed within the city [Patrão 2001, 41].

**Defining a methodology. The role of the conservation and restoration treatment**

The figure of Christ is represented standing in frontal position, with his head and chest leaning to the right. The hair falls in curly brown locks upon his shoulders, and his beard, which is also brown, ends with two curly twists turning inwards, also named ‘Spanish-style’. The fine details in his face are contrasted by a rough and less well-conceived, rather crudely constructed body. The angle of his arms, for instance, does not match the inclination of the chest, making the left arm shorter than the other. The right leg is also longer than the left. Both legs, hands and feet are also out of proportion, compared to the chest, and are too large and badly shaped, with poor anatomical details.

Various areas lack polychromy, especially in the area of the head. Iconographical symbols can be noticed in this devotional sculpture, such as the green spine crown, the purplish cloak and the green cane held up by the hands, which are tied up by a yellow rope. A white loincloth wraps around the hips.

The conservation treatment was carried out at the Ceramic Materials Conservation and Restoration Laboratory, at the Polytechnic Institute of Tomar (Portugal), and the material and technical study of the sculpture implemented in collaboration with the Conservation and Restoration Laboratory (Department of Chemical Engineering and Materials) of the University of Cagliari, Italy.

The polychromy of the sculpture was not in a good condition. The piece was totally overpainted and covered with a heavy layer of superficial dirt on top of a yellowed coating layer. There was a craquelure pattern visible in the flesh tones and paint was flaking. Several lacunae were present in the polychrome top layers and in the ground layers (mainly in the head, at the ends of the cloak, on the base and in the flesh tones). On the other hand, the ceramic support was in good condition. There were a few cracks present and a single wide gap was running down the left side.
of the left leg. The latter was presumably a manufacturing fault, due to shrinkage during the firing of the sculpture. A fine mortar fill had been applied to adjust the damage. This had been covered with a preparation and paint layer during the subsequent phase of manufacture. However, traces of this process can be barely seen in the mortar surface. As mentioned, a previous intervention was noticed during examination and was later confirmed by cross-section analyses by Optical Microscopy (OM). The observations revealed the application of several layers of overpaint, which became visible after a closer look, mainly in the flesh tones.

The openings in the surface, due to the craquelure and lacunae, made it possible to compare the most recent paint layer and the original one underneath. The new overpaint had less quality than the underlying work, both in colour and execution. This is noticeable in some details, such as the blood drops and eyebrows. The original version was in fact more refined, and had almost no craquelure. The original blood drops, which were visible through the lacunae on the knees, the left arm and the breast, showed clearly the artist’s skills. The blood drops on the forehead, the right thigh, the breast and the right side of the neck, are the result of irregular and quick brush strokes instead. The form of the blood drop is repeated on the forehead, on the neck and on the thigh. A similar scenario is also found when comparing the eyebrows. The left eyebrow corresponds to recent work, while the right is still the original.

To be able to execute the aimed characterisation of the so-called ‘Barros de Portalegre’, the most appropriate choice in terms of conservation and restoration was the recovery of the original colour below, and therefore the removal of overpaint. This allowed an enhanced aesthetic and stylistic knowledge of the original artwork (Figure 2). However, the removal of overpaint layers was selective. Only those most disturbing were removed, such as the poor quality repaints on the body of Christ and the white loincloth. This was decided after a close observation and due reflection, taking into account the final visual interpretation and aesthetic balance, but also regarding the principle of minimum intervention.

This study and intervention was the first step towards the identification of the material and technical characteristics that distinguish a certain group of artworks gathered by José Régio in the

![Figure 2. Detail of the figure’s face. Before (left) and after (right) selective removal of the overpaint. © CMLJR](image-url)
Portalegre region. It also complements the stylistic and typological studies already undertaken. Of course, the methodology established will be applied to other polychrome terracotta sculptures from the collection, which possibly can be identified as 'Barros de Portalegre', in order to clarify the origin of these pieces.

**Analytical methods**

Samples were removed for further examination and analyses to determine the characteristics of the terracotta support and the paint layers. Nine samples were collected and, after being embedded in epoxy resin (Epoxicure Buehler) polished. Observations were carried out, using an Optical Microscope in reflected light, with different magnifications. The purpose of this process was to identify the stratigraphy, as well as the pigments in the paint and the preparation layers. A Binocular Microscope Axioscope 40 (Zeiss) equipped with a digital high definition camera has been used to capture the images.

High-resolution imaging, using a Scanning Electron Microscopy (SEM) and elemental analysis by Energy Dispersive X-ray Spectroscopy (EDX) were used to identify the pigments and the preparation components. Furthermore, data acquired by Fourier Transform Infrared Spectroscopy (FTIR), aided the identification of the binding medium utilised. FTIR spectra were obtained and registered, in reflection, from 4000 to 400 cm$^{-1}$, with a 2 cm$^{-1}$ resolution and 64 scans, by a Thermo Scientific-Nicolet IN10 MX FTIR Microscope.

X-Ray Diffraction (XRD) was utilised to identify the mineralogical content of the support. This analysis was performed with a Philips X'Pert PW 3040/60 goniometer, using Cu-Kα radiation, 50 kV and 30 mA, automatic divergent notch graphite monochromator and a step size of 1°/20/min in the 4–65° 2θ range, with data acquisition by Philips.

**The terracotta support**

The sculpture is composed by a single block of terracotta (52 cm in height). The base, which has an irregular shape and rounded angles, can be described as a prism, measuring 16 cm width, 19 cm depth and 5 cm height. The figure was carved out of a clay block on a lathe. The hole in the centre of the base (with a diameter of 4 cm and a depth of 17 cm) results from the attachment system during this phase of the construction. Further, this hollow section allowed for better heat distribution during the firing process.

A sample of the terracotta support was removed from the base of the sculpture. The principal mineralogical components of the ceramic raw materials were determined with XRD analysis. The resulting graph shows the intensity in the various crystalline phases identified in the retrieved sample (Figure 3). Phases that present more intensity also contain quartz and feldspar. Some of the crystalline phases corresponding to the group of filosilicates were recognised, namely...
kaolinite and illite-muscovite. The presence of these phases in the sample indicates a low formation temperature. However, the fact that the object is a single block means that the mineral content throughout may be inconsistent. The point where the sample was retrieved can correspond to an area where phase transformation due to thermal transformations did not occur, as sufficiently high temperatures were not reached to transform kaolinite to illite-muscovite. This is a supposition substantiated by the traces of kaolinite, whose crystal structure is altered at temperatures around 600°C. The clay used in the modelling of the sculpture is the type illitic-kaolinitic. This provides plasticity to the clay, while quartz and feldspar provide the non-plastic component.

**Ground layer (original)**

Through examinations of the cross-sections with OM can be concluded that the ground layer has an homogeneous colour. Only the areas which are in contact with the coloured layers showed yellowish tones and a finer granulometry.

Elementary analyses and investigation in high magnifications by SEM on the same sections indicate that, for most part of the samples, the most recurring elements are calcium and sulphur, while few traces of silicium and aluminium can be found. Impurities are thought to be present in a gypseous preparation and white clay (kaolin) was found as a very thin top layer.

A sample retrieved from the border of a lacuna, situated in the left leg, presented very different features from the previous ones (Figure 4). Three layers, differing one from each other in colour, granulometry and composition, can be observed. The first layer, which is white and translucent and the closest to the support, reaches a maximum thickness of 200 \( \mu \)m, and its grains have very heterogeneous shapes, whose dimensions vary from a few microns to 100 \( \mu \)m. Since the primary analysis revealed the presence of calcium as the only dominant element, it seemed that this first layer is composed for the most part of calcium carbonate.

In the following layer we can still see the presence of calcium, accompanied by lead, which led to an increasing opacity of the material. Its characteristics are a white opaque colour and smaller grains. The lead oxide was employed as a mean to limit the number of preparation layers. This is a process explained in a seventeenth century art treatise, and which is also studied in other investigations on artworks dating from the same period [Barata et al. 2007, 25] [Barata et al. 2009].

In the last of the three layers, which is thinner than the others (30 \( \mu \)m approximately), there are no granulometric variations, but it differs from the previous ones in colour, which varies on yellow ochre, probably caused by the usage of paint or oil as a top layer. No relevant details about this layer were found when examined by SEM, in order to confirm the presence of elements with a low molecular weight, such as oils or paints.

**Flesh-tones**

In this essay, the characterisation of the materials has been extended to the layers of overpaint, since it may give us precious indications for the future study of other sculptures belonging to the category 'Barros de Portalegre'.

In all the observed samples retrieved from different skin areas, a highly compact rosy-coloured layer with a variable thickness between 100 and 350 \( \mu \)m, is visible on top of the yellowish preparation layer. Bigger translucent particles stand out from the background, as well as some other orange red particles. As shown by the SEM-EDX spectrum, lead is the element present in higher quantity, even though traces of calcium, silicium and aluminium are also visible (Figure 5). According to seventeenth-century recipes, the presence of lead might be explained by the use of white lead \((2PbCO_3\cdotPb(OH)_2)\) and minium \((Pb_3O_4)\), which would explain the nature of the orange-red particles observed by OM [Alves 1989, 219] [Serck-Dewaide 2002, 139]. The traces of
calcium (caused by the presence of CaCO$_3$), explains the nature of the translucent crystals. Silicium and aluminium could be impurities, due to the use of an extremely subtle layer of kaolin. A thin layer of yellowish paint separates the original strata from the overpaint, which is mainly composed of calcium carbonate and lead white.

**The cloak**

The following stratigraphic sequence was observed in the cloak, namely a white ground layer, an orange layer and a red coloured layer, probably applied in two different moments. The orange layer has a variable thickness of 20 to 60 µm, characterised by highly heterogeneous charges, both for shape and dimension. (Figure 6) The SEM-EDX spectrum marks the presence of sulphur, mercury and lead, due to the probable use of the pigments cinnabar (HgS) and minium (Pb$_3$O$_4$) [Barata 2009, 206]. Also the last red coloured layer is marked by the presence of sulphur and mercury, suggesting the use of cinnabar.

The loincloth

Observing the sample retrieved from loincloth through OM, a white coloured single layer of a dimension varying from 100 to 350 µm can be noticed. The particles have similar dimensions and are homogeneously distributed. The results of the analysis of EDX show a homogeneous distribution of lead and calcium, possibly due to a mixture of white lead and calcium carbonate. The presence of only one homogeneous layer and the absence of a preparation layer suggests the possible incompleteness of the sample. Further analyses are needed in order to clear this point. It is possible that this information only refers to the painted surface layer.

The spine crown

The sample retrieved from the crown is shown by OM as being composed of three layers, namely a preparation layer, a second white layer with various green grains and a top layer presenting both green and yellow grains (Figure 7). The EDX-spectrum of the central layer reveals the presence of lead, calcium, sulphur and minimum quantity of copper, silicium and aluminium. Lead white might represent the main pigment with an addition of gypsum, which may as well be deriving from the reaction with the preparation layer. The presence of copper must be due to the use of a light bottle green, malachite (CuCO$_3$·Cu(OH)$_2$), grossly ground. The superficial layer has green or light blue, white and yellow coloured particles of smaller dimension. The EDX-spectrum of this layer reveals the presence of silicium, aluminium, sulphur, sodium and lead, probably due to the artificial ultramarine and the white lead. The artificial ultramarine pigment has been used since the first half of the eighteenth century forward, giving us an
indication of an approximate time for the dating of the previous intervention, namely the repainting [Matteini 2007, 29]. Further analysis will be needed.

Figure 7. Cross-section taken from the crown (100x). © CMJR

Varnish

The spectrum analysis of FTIR confirmed the observations obtained with the SEM-EDX and let us analyse the upper layer of varnish, which was not original (Figure 8). Before the surface cleaning and the selective removal of overpaint, two samples had been retrieved from two different locations on of the body, namely on the left arm and on the right side at the top of the cloak. The spectra are comparable and both indicate the presence of a dammar resin [Matteini and Moles 2007, 145].

Figure 8. FTIR-spectrum from the non-original varnish. The characteristic absorption bands from dammar are marked out. © CMJR

Conclusions

The restoration of this artwork, together with the material and technical study, was only a starting point in the identification of the entire sculptural group of ‘Barros de Portalegre’. With this first step we can confirm that on the terracotta support, a gypsum preparation with some impurities was applied, followed by paint layers. calcium carbonate, white lead, cinnabar, minium and malachite were identified in these paint layer. All pigments can be found in seventeenth-century art treatises. In addition, the only pigment that could give us indications about the period in which the overpaint had been applied, was the artificial ultramarine, located in the top layer of the spine crown.
Henceforth, applying the same kind of analysis and conservation treatments to other sculptures, classified as ‘Barros de Portalegre’, seems mandatory. It will allow a more accurate comparison between the different pieces and, hopefully, give more information about their original provenance. There are certainly aesthetic similitudes, but old characterisation methods had been based on non-original, layers of overpaint. Meanwhile, other possibilities have emerged. It is possible that local workshops had made the transformations or former ‘restorations’, which now make these different sculptures similar. We expect that by removing overpaint in other pieces and by doing the same kind of material and technical study, we can finally understand if they are really a group with the same origin.

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Please use the following when citing this paper:

A study of two sets of Portuguese miniature high-reliefs.

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Abstract
Two sets of polychrome terracotta high-reliefs, representing two Christian narrative cycles, are studied in depth. Authorship, original historical or artistic contexts, and technological aspects of their manufacture were unknown. In an attempt to find answers, research was undertaken to evaluate the relationship between the elements of each set, the production techniques, the similarities in polychromy, the materials and the finishing layers. The written historical records have been compiled to trace any clues capable of contextualising these artworks. The authors have also tried to find references to this type of production, and possible sources of inspiration, by comparing earlier artworks. The research approach combined a traditional humanistic framework with a scientific study of paint samples.

Keywords: Cultural heritage, polychrome sculpture, high-reliefs, terracotta, metal coatings, composite materials, optical microscopy, SEM imaging.

Introduction
The two sets of polychrome terracotta high-reliefs are small in size, dating from the eighteenth century, and belong to the Museu Nacional de Arte Antiga, Lisbon (Portugal). The first set (of two) depicts two episodes from The Life of Saint Francis (Figure 1) and the second The Passion of Christ (Figure 2). This latter set consists of seven scenes, two of which are represented in Figure 2. Although these artworks correspond to different narrative cycles, they are quite similar in size and in manufacture. The same type of decoration was used in both sets. It is very likely that the two cycles were produced by the same workshop but, so far, very little is known about their provenance and the place for which they were originally intended. This information was lost after dismantling and removal of both sets from their original locations and their re-allocation to the museum collection in 1912. Accession to the museum was a consequence of the dissolution of the religious orders in Portugal in 1834.
Objectives

The main goal of the study was to reveal the historical journey undertaken by the artworks, filling in the missing links, creating a reliable historiography of the pieces. Optical techniques played a major role in understanding the technical details of the manufacturing processes. Recorded observations were made using visible (VIS) and ultraviolet (UV) light, by means of macro-photography, digital and Optical Microscopy (OM), and Scanning Electron Microscopy (SEM) imaging.

Contextualisation

Two provenances were recorded on accession to the museum in November 1912. Both series can be traced to churches in Lisbon. The Life of Saint Francis was associated with the church of St. Nicolas and The Passion of Christ with the convent of Senhor da Boa Morte [AMNAA 1912, 50-61]. The latter was the convent of the Oblate Sisters of the Most Holy Redeemer. In the former case, a devotion to Saint Francis of Assisi in a church dedicated to Saint Nicolas is incongruous. In the latter case, the existence of an eighteenth-century composition within the properties of a congregation founded much later, in 1827, is also dubious.

Several explanations have come to light. Firstly, some of the religious artworks from the São Francisco da Cidade in Lisbon were possibly transferred to the church of St. Nicolas after the decree of 1834 [1] [Vasconcelos 1916, 238]. Secondly, the convent of Senhor da Boa Morte, built in Lisbon in 1736, was transformed after the 1834 decree to the Franciscan Missionaries of Mary. At this time the furnishings of the convent came into the possession of the National Treasury under the First Republic in 1910 [Silva 1943, 79]. The Oblate Sisters owned the cycle of The Passion scenes. These events suggest two common issues, namely that both cycles were meant for religious spaces in Lisbon, which in turn leads to the idea of a local workshop production, constructing artworks for the Franciscan religious orders. It is likely that these orders (of monks and nuns) owned these artworks. Under these circumstances, it is feasible that the two cycles could have been accessioned to the same museum in the same month. Documents should still exist relating to the dispersion of the legacies of both orders at the start of the twentieth century.

Themes

The design of a specific pair of artworks depicting two moments of the life of Saint Francis (St. Francis Embracing the Crucified Christ and The Temptation of St. Francis) is perfectly plausible, but a more extensive composition is also possible. A search for other episodes with similar features in parish churches existing in Lisbon before 1834 has so far yielded no result.

The second set, The Passion, is obviously incomplete. It is described as representing The Flagellation of Christ but this set comprises seven scenes, from which the Flagellation is absent [AMNAA 1912,53]. The scenes that are present are: 1) The Garden of Gethsemane, 2) The Betrayal of Christ, 3) The Crowning with Thorns, 4) Ecce Homo, 5) The Raising of the Cross, 6) The Crucifixion and 7) The Descent from the Cross. Three of the extant scenes (1, 3 and 6) could also have been part of the five ‘Sorrowful Mysteries’. The Mysteries iconography belongs to the traditional fifteen ‘Mysteries of the Rosary’, which were standardised by Pope Pius V. The implementation of this iconography can be found in a famous baroque altarpiece dedicated to Our Lady of the Rosary, in Codal (Aveiro) [Gonçalves 1991, 165]. This includes polychrome wooden high-reliefs, also small in size, and could be related to The Passion series. This assumption was however discarded due to the material and stylistic coherence across the seven elements. Nevertheless, this interconnection allowed for the potential existence of workshops specialising in the production of sculptural miniatures, active in the eighteenth century in the central region of Portugal, to be taken into consideration. This line of research is being pursued.
Figure 1. Two scenes from the Life of St. Francis. **Left:** St. Francis Embracing the Crucified Christ. **Right:** The Temptation of St. Francis. Both: 27.5 x 23 x 7 cm. Museu Nacional de Arte Antiga, Lisbon (MNAA242-243). © A. Le Gac

Figure 2. Two scenes from The Passion of Christ. **Left:** Garden of Gethsemane (27.5 x 21.2 x 6 cm). **Right:** Crowning with Thorns (27.5 x 21.2 x 5.7 cm). Museu Nacional de Arte Antiga, Lisbon (MNAA244-250). © A. Le Gac
Influences

To a greater or lesser extent, paintings and engravings, which were highly widespread across Europe since the sixteenth century, have influenced the composition of the high-reliefs. Rather than following the official illustration of the Life and Miracles of St. Francis (as seen in the narrative cycle of frescoes painted by Giotto in 1297-1300 in Padua, Italy), Saint Francis Embracing the Crucified Christ is primarily based on a theological approach, according to the new directives from the Council of Trent (1545-1563). In this context, the miniature relief from Lisbon is a fairly faithful transposition of a painting by Bartolomé Esteban Murillo, commissioned in 1668 by the Capuchins for their convent in Seville [2]. The Temptation of Saint Francis derives directly from the fourth of ten frescoes on the Life of Saint Benedict (overpainted by Bronzino in 1526-1528) of the Badia in Florence, and in a painting by Alessandro Allori from 1587. In the relief the protagonists of the temptation, a devil and an elegant woman, are of particular note. This representation already existed in the eleventh century, as can be seen on a capital in the choir of the abbey of Saint-Benoît-sur-Loire, France. Temptations were retold in the numerous hagiographies of the saints and were therefore interchangeable.

Regarding the cycle of The Passion, in some scenes there appear to be either direct or indirect echoes of the most famous series of woodcuts and copper engravings by Dürer (The Large Passion Cycle c.1497-1500, The Small Passion Cycle 1508-1510). Moreover, Italian influences that are found in Dürer's work are also perceptible, for example in the Descent from the Cross. Other influences are identifiable in the Garden of Gethsemane, Betrayal of Christ and Crowning with Thorns, which were based on engravings by Martin de Vos and followers [3], while the Ecce Homo seems strongly influenced by an etching of Rembrandt from 1655 [4].

The transposition of such two-dimensional sources into three-dimensional artworks demonstrates that the author of the cycles invented relatively little himself. It was however no less a challenge. The sculptor (or sculptors) had to shape the figures in the foregrounds almost fully in the round and manage the multiple points of view. The higher the figures were, the more sophisticated they are composed. Comparisons show that the sculptor tended to simplify the original pictorial examples for the Passion scenes, that he was less effective in combining different compositions of the copied prints, and that he often reproduced figures with a seeming lack of anatomical knowledge. The figure of Christ, however, was created with great accuracy in both cycles. Regardless the dimensions, his features are extraordinary alike across the scenes. These aspects are indicative of the probable collaboration of a master and several individuals, working on a production line of miniature reliefs.

Technological process

The construction of the sets differs greatly. In the pair of episodes concerning Saint Francis, each element was made separately. The figurines were made of clay, the ground of cork, and the plants of fabric. Each box was prepared as a backdrop, with the wooden surfaces of the bottom and inner sides of the box corresponding to the sky. Only afterwards were the polychrome elements placed into this surrounding.

In the cycle of The Passion, each scene was conceived as a complete separate piece. The modelling task started with a clay plate over which rocks, trees, architectural elements and characters were directly shaped, and then fired. The terracotta pieces were some three centimetres smaller than the boxes in which they were displayed. So the terracotta pieces were glued into the boxes and calcite putty (likely chalk combined with a binder) was applied on the upper part of the scenes to compensate for the existing gap. The resulting white chalky putty was further levelled. Then the scenes were painted. Finally, the boxes were embellished with a garland of flowers to frame each composition, also to conceal the aforesaid subsequent addition of the calcite putty. All boxes of the two sets are 27.5 cm in height. This suggests that the dimension issue was crucial and that, at some point, both cycles were displayed in similar viewing conditions.
At the time of their accession into the museum, the dismantled boxes were still covered with glass panes, roughly adjusted but without any attachment point or moulding frame to keep them in place. This unfinished appearance made the authors believe that each narrative cycle was once part of a larger structure. It could be a glass-fronted cabinet (as many relics are displayed in Portuguese chapels) or on display as an altarpiece. The eighteenth-century reliquary altarpiece devoted to Christ in the dissolved Dominican convent in Aveiro serves as an example. Its miniature wax high-reliefs had been displayed in small rectangular glass-fronted niches (Figure 3). The cycles of *The Life of Saint Francis* and of *The Passion* could equally have been arranged that way, placing each episode side by side or one above the other within a now missing architectural structure.

![Figure 3. Reliquary altarpiece showing scenes from the life of Jesus from the Dominican Convent (defunct), Aveiro, Portugal. Museu de Aveiro (MA70/M). © A. Le Gac](image)

**Polychromy**

The palette of colours, along with multiple metallic effects produced in both sets, readily declares the richness of the polychromy. Digital microscopic examination carried out on the few existing paint traces clearly showed that, in the cycle of *Saint Francis*, the ceramic support was previously covered with a white ground, while by contrast, the other cycle received none. Optical microscopy (OM) however, was crucial to determine materials of the layered structures. Each layer was well-differentiated when observed with a variety of exclusive filters and under three ultraviolet wavelengths (390/470/515 nm).

The stratigraphy of the garments, which exhibit a metallic lustre, have the following superimposed layers (Figure 4): 1) An organic translucent size applied over the ceramic support to decrease its porosity; 2) A lead-based white ground of a regular thickness; 3) A yellow mordent, always brushed over the priming, regardless of the colour of the metal leaf to be subsequently attached; 4) A hand-beaten silver or gold leaf; 5) A green, blue, purple, red or yellow glaze applied in several coats as a finishing layer, taking advantage of the specific shade and lustre of the precious metal underneath to achieve subtle variations of colour.
Backscatter electron (BSE) and secondary electron (SE) imaging using the Scanning Electron Microscope (SEM) showed that matt gilding (or silvering), relying on the application of an oily mordent, was the only technique used here. The metal coatings always appeared to be the result of a rigorous application of tiny fragments of metal leaf, with no further polishing. The glazes applied over them contributed to the required brilliancy. In both cycles, the glazes were often composed of dyes (cochineal, madder), or of finely ground pigments (lead white, vermilion, minium, verdigris, Prussian blue) combined with the binder. This was perfectly highlighted by optical imaging in light and dark field, interferential contrast, transmitted and polarised light, and under UV excitation (Figure 5). The glazes used on the cloaks of the Virgin and Saint Peter, and the violet glaze applied to the tunic of Christ, are particularly noteworthy since these colour practices are known to have been particularly developed in Northern Europe, namely in Germany [Richter and Pelludat 2004, 144-174], but is little reported in Portugal.

Figure 4. Paint samples removed from the Angel’s wing (St. Francis’ Life). Left: Longitudinal section, OM micrograph x50, interferential contrast, bar scale: 500 µm. Centre: Cross-section, OM micrograph x200, interferential contrast, bar scale: 100 µm; Right: SEM (BSE mode), micrograph x1,000 – 20 kV, bar scale: 10 µm. (S) © A. Le Gac

The flesh tones were always painted pink, whatever their gender, age, social condition or ‘degree of holiness’ [Serck-Dewaide et al. 2002, 136-141]. Moreover, regardless of the scene reproduced in the cycle of The Passion, the flesh of Christ is invariably pink, and not pale as would be expected in the Crucifixion and the Descent from the Cross. Samples of the flesh tone, which were examined microscopically, showed that realgar, vermilion, minium and earth pigments, as well as lead white and a red dyestuff were used. None of the flesh layers were polished. The wounds of Christ were systematically reproduced by raised drops of blood, perfectly round and curved. Their size depended on the scale of the body. These drops, typically used in Iberian baroque sculptures, were prepared by firing orpiment in tiny phials, as described in the recipe of the anonymous book of Secrets published in Lisbon in 1794 [Segredos 1794, 41] [Moresi 2002, 520-523], which gives evidence of the existence of such knowledge in earlier time. The strong similarities between the figures of Christ in both sets suggest that they were produced by the same painter.

The care taken to reproduce the visual and tactile accuracy of any type of material is also evident in the pictorial treatment of the buildings. The imitation marble coating and azulejos (tile) decoration of geometric patterns, that were a major aspect of Portuguese architecture, are visible on the exterior of the palaces depicted in the cycle of The Passion. These surfaces were further extensively varnished with a dry oil-based coating (fluorescing bright yellow under UV light) (Figure 5), which was meant to represent the polished stone and glossiness of glazed ceramic tiles.

Finishing touches
A wide range of materials was employed in the finishing top layers. None of these materials belong specifically to the painting trade, but all were crucial to achieve the full plastic expression
of each scene (Figures 6 and 7). The flora was treated differently in each set. In the scenes from the *Life of Saint Francis* (Figure 6), a white taffeta fabric was the main material employed for the corolla of flowers consisting of wild roses, primroses and sweet William. This very thin fabric was starched so that the petals would retain the required shape, and their rounded edges would not fray. A green thread of metallic wires was used for producing the stems, leaves and calyces. The bush, in which Saint Francis threw himself, is made of a long white metallic wire. Minute triangles of metal foil were welded onto this wire and covered with a greenish brown glaze, to imitate sharp thorns. These can be associated with the wounds on the flesh of the saint. The thorns give his perceived torment a higher degree of realism.

![Figure 5. Paint samples of green glaze from Magdalene’s dress (OM). Left column (#1): verso; Right column (#2): recto. (a) light filed; (b) dark field; (c) interferential contrast; (d) polarised light; (e1) UV 470 nm filter; (e2) UV 515 nm filter. © A. Le Gac](image)

In the cycle of *The Passion* (Figure 7), cardboard was used, rather than fabric, in the vegetable garlands that frame each scene. Leaves were painted brown, and the white lilies and daisies were simply glazed with a colourless varnish. Their stamens consist of filaments made of thread, topped by anthers made of red glass. In each case, the accurately imitated flowers are symbols of Christian iconography [Barreyra 1698] [Franco and Basto 2012, 9-12].

While the ropes in the scene of the *Raising the Cross* are also made of twisted threads, the knotted cord girdle, which the friar wears in *The Temptation of Saint Francis*, is actually modelled in clay. In both cycles, hair was used to imitate the rough fabrics. Examples are the woollen homespun of Saint Francis and the garment of the executioners and bystanders. The source of the hair is
difficult to identify as the pieces are cut into small sections removing the root and tip. When viewed under a microscope, the hairs are cylindrical and opaque, 30-45 µm in diameter, but also covered with paint residues, which makes their cuticle patterns difficult to examine. According to SEM imaging, the cuticle scale pattern observed seems to indicate animal hair, maybe goat. The hair was either preserved in their natural state, corresponding to different shades of brown (cycle of *Saint Francis*), or dyed blue and red (cycle of *The Passion*). They were applied alone or mixed together according to the required colour. High magnification images enabled verification that the hair was not embedded within the paint layer but attached to the surface. This indicates that they were applied to the paint surface while it was tacky, the excess of hair being removed afterwards. This practice has been observed elsewhere in Portugal, on an eighteenth-century wax-cast figurine of Saint Francis wearing a very realistic rough homespun [Le Gac et al. 2014] [Le Gac et al. 2015, 808].

In addition to fabrics and hair, tiny glass flakes were also used in the creation of the works. When applied to the landscapes (painted yellow, brown or green), the transparent, white, green and golden flakes enhance the mineral aspect of the imitated rock. When applied to the blue sky in the episodes of the *Life of Saint Francis* (Figure 6), they are translucent, whitish, clear blue, dark blue and red, thus giving the blue background the elusive, visually shifting effect of a jewel that sparkles, symbolising transcendence. In this latter case, the bigger flakes have a conchoidal fracture, indicative of glassy amorphous crystalline material. Moreover, the blending of different coloured glass produces different reflective tones, depending on the angle from which the scenes were observed. This was probably a well-thought-out technique.

![Figure 6. Left. Finishing touches to The Temptation of St. Francis. © A. Le Gac](image1)

![Figure 7. Right. Finishing touches to The Raising of the Cross. © A. Le Gac](image2)

On the bluish sides of the cases for the scenes of *The Passion* (Figure 7), the glass is a finely ground and dense golden powder, mixed with ribbon-like brass-flakes, which was added to impart a glittery shimmer effect. This practice is the foundation of the ‘venturina-technique’, as described by Bernardo Montón in his book of *Secretos de las Artes Mecánicas y Liberales*, published in Madrid in 1734, or of the ‘aventurine-decor’ (*fonds aventurinés*) described by Jean Félix Watin in his treatise of 1772 [Montón 1761, 122] [Watin 1773, 172]. The technique consisted of sprinkling...
metal flakes over a fresh paint layer, then shaking off the excess after half an hour, and finally exerting a slight pressure on the flakes through a paper after three days, prior to the application of several layers of varnish. The final coating normally applied was not used in these reliefs.

Lastly, in the two scenes of The Passion that include building façades, sand was used to imitate the grainy appearance of mortar (Figure 8). The technical principle seems the same as at the application of glass.

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Figure 8. The Ecco Homo under Ultraviolet (UV) radiation. © A. Le Gac
Conclusion

Even though the artworks studied were derived from two-dimensional artistic sources, they were clearly meant to create an effect more sculptural than pictorial. Although three-dimensionality is inevitably inherent in modelling work, the plastic effects are conclusively achieved through the choice of materials and their specific final texture. The exuberant top layers observed in such small high-reliefs, and the imaginary universe they helped to create, were also rooted in earlier practices, namely those found in the jardins clos produced since the thirteenth century onwards, and most specifically those fabricated in Malines (Brabant) in the early sixteenth century. The transfer of techniques from Flemish art, which took place in Portugal, generated a strong renewal of interest in the eighteenth and nineteenth centuries.

The observed complex arrangements, which were revealed during this research, make it possible to suppose that there had been a collaboration of individuals with specific skills, within a workshop, relying on a sculptor, a painter-gilder, and several other craftsmen. The strong parallels between the compositional elements in each cycle, namely the similar physiognomy of the figures, the chromatic effects, and the similar characteristics of materials, strongly suggest that these artworks were made within the same artistic circle. Based on the pigments used and the technological processes involved, their accurate dating, although still a work in progress, seems to tend toward the eighteenth century.

Acknowledgements

The authors are grateful to António Pimentel, director of Museu Nacional de Arte Antiga, Zulmira Gonçalves, director of Museu de Aveiro, dr. José António Rebocho Cristo from Museu de Aveiro, and Emanuel Cipriano, responsible for the archives in São Nicolau’s Church in Lisbon, for their valuable collaboration. This work was supported by Fundação para a Ciência e Tecnologia (FCT) in the framework of the project: GILT-Teller – Um estudo interdisciplinar multi-escala das técnicas e dos materiais de douramento em Portugal, 1500-1800 (PTDC/EAT-EAT/116700/2010). Teresa I. Madeira acknowledges the support of FCT under Contract SFRH/BPD/69627/2010. Camila Remonatto is grateful to the Universidade de Lisboa - Fundação Amadeu Dias for her grants in the framework of the scientific research project: Estudo de um conjunto setecentista de altos-relevos miniaturais em barro cozido policromado (UL-FAD/2012-2013/05).

Endnotes

1. Unfortunately, evidence of the specific transferral of the compositional pieces of the Life of Saint Francis to the church of Saint Nicolas, was not found when researching the existing archives.


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The discovery of the painted decoration of the Jacobean chimneypieces of Apethorpe Hall, Northamptonshire, UK (c.1624).

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Abstract
The detailed examination of the four Jacobean chimneypieces at Apethorpe Hall has confirmed that they were originally painted and gilded, using expensive materials with included natural ultramarine and Naples yellow, and extremely sophisticated painting techniques which may be compared with those of the leading artists of the period, such as Rubens. The discovery of the use of a common fungus, Witches’ Butter (*Exudia Glandulosa*), to manufacture a translucent brown pigment may have important implications for the re-assessment and attribution of early painted decorations. The chimneypieces at Apethorpe were a key component of the 1622-1624 decorative scheme. The rediscovery of their original polychrome expands not only the technical and aesthetic appreciation of the chimneypieces, but also broadens the understanding of the complex iconography and allegorical meaning of these rare English renaissance masterpieces.

Keywords: Architectural paint analysis, chimneypiece, polychrome sculpture, natural ultramarine, Naples yellow, Brown Witches’ Butter, King James I, mason’s marks.

History of Apethorpe Hall
In May 1622 King James I of Britain issued a command to Sir Francis Fane ‘(…) to new build and enlarge his house at Apthorpe …for the more commodious enterteynment of his Majesty and his company, at his repaire into those parts for his princely recreacon there (…)’ [NRO 1622]. Sir Francis Fane promptly embarked on a major building campaign to extend and lavishly decorate the State Apartments of Apethorpe Hall, which included the creation of four extremely ornate chimneypieces, to comply with the King’s wishes. These four surviving early seventeenth-century chimneypieces have been called ‘the jewels of Apethorpe’ and are rated as one of the most important series of English renaissance stone chimneypieces. They are extremely significant because of the unique material evidence they retain which sheds new light on early seventeenth-century Jacobean decorative practice and painting materials [Hughes 2006/2007, 23-25] [Hughes, 2009].

Apethorpe Hall, in Northamptonshire, England, is a large Grade I listed country house which dates from the late fifteenth century, but was significantly remodelled in the sixteenth, seventeenth and eighteenth centuries [English Heritage 2006]. It is agreed that the early seventeenth-century Jacobean period, when the house was visited by King James I, on eleven separate occasions, is the most significant period of the building’s history. All later alterations generally respected the room plan of Sir Francis Fane’s early seventeenth-century State Apartments, although the walls and windows have been subject to extensive and repeated replacement, the ceilings and chimneypieces created by Sir Francis to impress King James remain in situ, witnesses of the golden Jacobean Age of Apethorpe.

After WWII, from 1951 until 1982 the house was used as an Approved School and later a Community College. After the closure of the college the building fell into such a state of decay that it was eventually placed on the English Heritage Building’s at Risk register. In 2006 Apethorpe Hall was compulsory purchased by the UK government and passed to English Heritage which then began essential repairs. The repair phase offered an opportunity to carry out in-depth research and analysis of the building. One of the research goals was to establish the works carried out by Sir Francis Fane between 1622 and 1624 for the more commodious enterteynment of the King James I. My part of the investigation, as a paint analyst, was to discover and decipher any surviving decorative paint finishes dating from this period.
**Research programme**

Few intact Jacobean interiors survive. The study of the period is based on chance survivals, a random selection of contemporary descriptions, inventories and accounts, and some idealised portraits. It was assumed that Francis Fane spared no expense on the interiors he created between 1622 and 1624 for King James, and they would have reflected the height of contemporary fashion. The study of high status Jacobean buildings requires an understanding of how these buildings were used to gain access to the monarch. When James became king in 1603 he exclaimed that he had been admitted to a ‘paradise of pleasure’. Eminent courtiers vied to entertain him at their country estates and cater to his every whim. King James neglected state affairs to indulge in long drunken hunting sprees at Apethorpe and other estates. Francis Fane’s family benefitted from this close access to the monarch. So the King’s edict to improve Apethorpe, was both a curse and a blessing, promising future visits, but while the works were being carried out, the King could not visit Apethorpe. The extensive building works were completed within two years, which was a relatively short period of time considering the scale of the works. On the 31st of July 1624 King James returned to Apethorpe to view the new works. What did he see? And was he suitably impressed? A reconstruction plan of the original 1624 room arrangement suggests that the most novel aspect of the Fane’s new State Apartments was a set of inner, more informal rooms and a privy back-stair located behind the Kings Chamber. This room arrangement would have provided the king with an unrivalled degree of privacy.

Paint research established that the new ornate plaster ceilings at Apethorpe were originally simply finished in a white distemper. But during the late sixteenth and early seventeenth centuries the chimneypieces had become more ornate feature of the room and were always painted and embellished [White 2006]. The research question to be answered was not ‘Were the fireplaces originally decorated in polychrome?’ but ‘Has any trace of the original decoration survived and what how were the chimneypieces decorated?’

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**Paint stripping of polychrome decoration in the UK**

In the UK the investigation of the polychrome on sculpture and architecture is hampered by the widespread belief, despite evidence to the contrary, that dressed stone and wood panelling of sixteenth and seventeenth English interiors was never painted. This myth is so strongly upheld...
that any trace of original paint, where it does survive, is assumed to be a Victorian addition, and removed with a zealous vigour ‘to return it to its natural colour’. As evidence of applied paint is destroyed, the myth is perpetuated. For much of the twentieth-century scholars have conveniently overlooked the reams of historic accounts, which prove that for centuries painters have been busily employed painting, marbling, graining, and gilding all types of stone and wood. The art historian Margaret Whinney in her seminal book, *Sculpture in Britain 1530 -1830* refused to engage with the issue of polychrome sculpture, merely noting in passing that, ‘(…) it is difficult to believe that they (sculptures) were covered in paint (…)’ [Whinney 1964]. This denial of applied decoration reveals more about mid-late twentieth ‘truth to materials’ ethic and a taste for stripped pine, than Jacobean decorative conventions. An important example of paint stripping is the tomb of Elizabeth I which still stands in Westminster Abbey. This well documented work was carved by the famous sculptor Maximillian Colt and decorated by John De Critz, the king’s Sergeant Painter, who in 1607 received the enormous sum of £100 for painting and gilding the tomb and effigy of the queen [Auerbach 1961] [Murrel 1993]. Today no traces of De Critz’s paint and gilding remain. The queen’s tomb is now, rather ironically, admired for its whiteness and crisp detailing.

Figure 2. Chimneypiece in the King’s Chamber. Apethorpe Hall. © Apethorpe Hall

**Initial examinations of the Apethorpe chimneypieces. Paint residues and mason’s marks**

In 2006 the initial assumption of the building historians, members of the Apethorpe research team, was that the Apethorpe chimneypieces had not been painted originally [English Heritage 2006/7]. During the course of the investigation, access to the valuable ornate chimneypieces was problematic as, at the outset of the works programme, the chimneypieces were protected by alarmed wooden boxing. When I eventually examined the chimneypieces in 2008, on the removal of the boxing, I assessed that 98% of the surface of stonework of the chimneypieces was exposed. Traces of modern distemper or lime-wash decorations were visible on all four of the chimneypieces in the recesses of the mouldings. But in places traces of brightly coloured paint were visible beneath the later lime-wash. These coloured paints were assumed to have been applied by the pupils of the Approved School sometime between 1951 and 1978 (Figures 1 and 2).
All four of the chimneypieces were constructed from locally sourced, fine-grained oolitic limestone, inlaid with small pieces of polished black marble, known as touch-stone. The supporting columns and bases were made of marble. One of the exciting discoveries at Apethorpe was a particularly large number of mason marks on the surface of the 1622-1624 stonework. The function of mason's marks is to identify the working of a piece of masonry by a particular mason, to allot payment. While mason's marks were observed on the blocks of stone used for the architectural elements of the chimneypieces, they were not found on the sculptural or more elaborately carved sections. The Apethorpe mason’s marks identified the workshop responsible for the dressing of the stone as that of a local mason, Thomas Thorpe of King’s Cliffe (d.1626). It is suggested that this local workshop worked in close collaboration with an ‘elite group’ of London sculptors who travelled up from London to work the local stone at Apethorpe. However, the building historians suggested that, because the mason’ marks on the chimneypieces appeared to be displayed with ‘deliberate prominence’, they were intended to be visible and act as an advert for the masons, and so suggested that the marked stonework would not have been painted as this would have obscured the ‘signature’ mason’ mark [Alexander and Morrison 2006/7] [Alexander and Morrison 2007] [Alexander 2013]. This was not the case.


King James was celebrated as the champion of peace and harmony, a wise king and a religious leader. The scheme contains no references to the Mildmay-Fane family which owned Apethorpe [White 2008]. Before entering the remodelled State Apartments, King James had been confronted by a life-sized painted stone statue of himself, dressed in robes of state, prominently positioned in the niche above the central external doorway. The iconography of all four chimneypieces is complex and includes allegorical references which indicate the high level of monarchical glorification and Jacobean propaganda of which informed Fane’s new decorative programme.

When the alarmed boxing was eventually removed from the chimneypieces, I began my investigation with an examination of the chimney piece within the Duke’s Chamber. This is, understandably, the smallest and least grand of the chimneypieces in the series, as it is located within the inner private rooms behind the King’s Chamber (Figure 3).

It is assumed that this chimney piece was made entirely by the London team of craftsmen, as it does not bear the mason’s marks of the local workshop. The chimney piece bears the arms of the Duke of Buckingham, the king’s favourite and most powerful courtier. The prominent decorative feature is a relief panel bearing a warship in full sail, flying two English flags. This is thought to be a reference to the Duke’s position as Lord Admiral. Visual examination of the surface discovered traces of a partially removed layer of white distemper or lime wash, overlying traces of a bright yellow paint. Material analysis of the yellow paint established that it contained barium and chrome, suggesting that the yellow paint was a modern chrome yellow, probably applied by the boys of the Approved School using post-1950s paint from their art classes. But close examination revealed traces of older paint layers in the recesses of the carving, which could have been applied in the early seventeenth century.

Paint samples removed from recess of the ship’s sails, examined in cross-section, exhibited a sequence of thick opaque lead-based white layers, with some modelling of the surface in a brown paint. This brown paint was tinted with a transparent fibrous brown material which, when examined under high magnification, it was seen to be composed of strands of mono-cellular filaments. It was initially assumed that this material was mould growth, but its inclusion in the paint layers found on the other chimneypieces suggested that this brown organic material was being used as a pigment. (See Withdrawing Room chimneypiece below.) It was evident that the surface of the chimney piece had been stripped and cleaned at some date. Small sections of fine wire from metal scouring pads, which are evidence of a zealous paint removal campaign, were found amongst the accumulated paint residue. Fragments of black shiny enamel paint were discovered in the detritus of paint which had collected in the barrels of the cannons. (This black paint was...
also found on the gesso preparation of the carved wooden architrave of the door leading into the King's Chamber. The stratigraphy of paint samples removed from the background behind the sea displayed a complex layered structure of translucent grey, black and grey-green coloured paint, tinted with finely ground coal (used as a pigment and in common use until the late seventeenth century), a little yellow (unidentified), and red lead. This could suggest that the ship relief was originally painted to depict a ship with billowing white sails, shiny black canons, sailing through a grey stormy sea.

![Figure 3. Chimneypiece in the Duke's Chamber, detail. Apethorpe Hall. © Apethorpe Hall](image)

**The Long Gallery. Gold leaf, dead flesh and blues skies**

My investigation moved on to the chimneypiece in the Long Gallery (Figure 4). This is the largest and grandest of the series, befitting the scale of the room. It contains a large statue of the Old Testament King David (assumed to be a portrait of King James) playing the harp, flanked by David's sling and shot, and Goliath's decapitated head pierced with a sword. Again, close examination of the surface of the stone revealed traces of school-boy daubs, but also the remains of early paint layers and signs of paint stripping. Substantial traces of paint were retained in the recesses in and around the hair, moustache, teeth and tongue of Goliath's severed head. Coarsely textured red and brown paint removed from the moustache, examined in cross-section, revealed that they had been applied over a white undercoat layer and contained red lead mixed with the distinctive brown fibrous mono-cellular filament already observed on the Duke's Chamber chimneypiece. Intact layers of a black paint from Goliath's nostrils also contained traces of the mono-cellular brown (see below). The residue of the paint stripping campaigns had collected within Goliath's open mouth. A detached fragment of gold leaf applied on a size layer and a white undercoat was discovered within the mouth cavity. This is the only evidence of gilding being applied to the chimneypieces.

Faint traces of blue-grey and green paint were observed on Goliath's face, ingrained onto the surface of the stone in the recesses around the eyes and nose. These colours may have been used to accentuate the fact that the giant was dead. Paint samples removed from the junction of the background and David's sling, contained lead white tinted with small particles of blue, perhaps
suggesting that this area was painted to imitate a blue sky. A section of the broken pediment bore traces of lead-white layers tinted with red, grey and ochre pigments, evidence that the architectural elements were originally painted to imitate a coloured marble. These findings indicate that the architectural elements of the chimneypiece had been originally decorated to imitate marble while the figures and relief panels were painted in life-like ‘proper’ colours. Goliath’s face was depicted with a realistic gruesome deathly pallor.

The Withdrawing Room chimneypiece. The discovery of natural ultramarine and the naming of Brown Witches’ Butter

The over-mantle relief of the chimneypiece in the Withdrawing Room depicts the Sacrifice of Isaac, a common allusion to kingship, was originally flanked by two free-standing figures of the theological virtues, Faith and Hope (now lost). The lintel above the fireplace is decorated with a large open book, most likely a reference to the King James Bible, an English translation of the bible, ordered and approved by James himself. The stone book is flanked by two muscular arms emerging from clouds. One (left) is holding a sword and the other (right) a sceptre. The lintel is supported by two marble columns surmounted by carved stone capitals.

A distinctive blue paint, observed on the background of the collars of the carved stone capitals, had previously been dismissed as the work of the school boys. Samples of the blue paint mounted in cross-section revealed that the blue pigment was quite coarsely textured and that it had been applied over a lead-white and chalk based undercoat. Material analysis (SEM-EDX) established that the blue pigment did not contain copper or potassium, and so was not azurite, blue verditer, or smalt, which were the three blue pigments commonly used for architectural decoration in the early seventeenth century. This suggested that the pigment was natural ultramarine. The presence of a grey discoulouration on the surface of the paint layer served to confirm the pigment identification, as ultramarine is known to discoulour in the presence of acids. The acid fumes from the fire were probably responsible for this reaction (commonly known as ultramarine sickness). The coarse texture of the paint is due to the clumping of the pigment particles, which is another characteristic of natural ultramarine. The pigment was too coarsely textured to be French ultramarine, which was developed in 1828. In the sixteenth and
seventeenth centuries the pigment was known as ‘Ultramarine of Venice’. Ultramarine was made from the semi-precious stone lapis lazuli mined in Afghanistan. The raw lapis lazuli reached Venice via the silk routes, where it was processed into pigment form and then sold throughout the rest of Europe (probably smuggled into countries in sealed packets to avoid taxes, as it rarely appears on import records) [Kirby 2010]. In 1600 the artist Nicholas Hilliard notes that the cost of an ounce of best ‘Ultramarine of Venice’ was £11.10 (English pounds) and comments that ‘(…) instead whereof (instead of ultramarine) we use smalt of the best, and blue bices (azurite) of divers sorts (…)’ [Hilliard c1600]. The use of this expensive pigment on architectural elements demonstrates the ostentation of Francis Fane’s decorative scheme. I have never encountered the use of natural ultramarine for the decoration of architectural elements.

Examination of the two muscular arms emerging from the clouds revealed trace of browns and dark flesh tones. Once again examination of removed paint samples in cross-section showed substantial traces of the distinctive brown translucent mono-cellular filaments (figure 5A and 5B). This material had been applied directly onto the surface of the stone, and had also mixed with lead and chalk. SEM-EDX analysis of the filaments could not detect any element, confirming that the material is organic. Peter MacTaggert, an experienced pigment analyst, generously examined images of the filaments and identified the material as the cyanbacteria (Nostoc), a jelly-like fungus which is found on decaying wood. A common variety is Exudia Glandulosa, more commonly known as Witches’ Butter (but also known as Fairy Butter, Jelly Star, Fallen Star or Powdr Ser). As the fungus contains photosynthetic pigments which may have led to the material being used as a pigment. The translucent brown pigment, which I have named Brown Witches’ Butter, had been used to create the dark flesh tones of the arm, and had also been applied over a pink layer (a mixture of lead white and red lead) to provide a more subtle darker skin tone.

A paint sample taken from the clouds examined under UV fluorescence provides further evidence of the use of sophisticated methods and materials. A bright red layer applied over a white undercoat had been overpainted with a red tinted varnish or glaze to add sheen and depth to the surface of red. It is surprising to discover that the clouds were originally painted red (Figure 6A and 6B). This finding may lead to an understanding of iconographical significance of the relief panel.

The Kings Chamber chimneypiece. Masking construction joints with painted marbling and Naples Yellow

It was fitting that it was the chimneypiece within the King’s Chamber, the room used by King James, retained the most compelling evidence of the skill and sophistication of the painted decoration applied to the chimneypieces at Apethorpe. The overmantle is dominated by two
female seated figures, representing War (left) and Peace (right), revealed behind curtains which
are held open by a flanking pair of term figures. The lintel is decorated with a hunting scene, a
direct reference to King James’ main recreational pursuit at Apethorpe. The chimneypiece is
made from fine-grained oolitic limestone, supported on column shafts made from a grey-green marble.

By sheer good luck I examined the surface of the chimneypiece on a bright December morning
when the low raking winter sun illuminated the bodies of the two seated female figures. The traces of paint on their exposed breasts had been thought to be the work of saucy schoolboys. But close examination of the surface revealed an extremely subtle use of shades of dark blue, grey and pinks to suggest delicate and life-like skin tones, comparable to those found on contemporary paintings by artists such as Rubens. Large areas of the grey-pink skin tones appear to have survived on the figures. Analysis of the surviving paint revealed the presence of high quality pigments such Mars red or Venetian red, red lakes and Naples yellow (lead antimonite). Naples yellow was used by artists in the early seventeenth century but was not commonly used for architectural housepaints until the mid-late eighteenth century. Indeed it is suggested that the addition of Naples yellow to the highlights of flesh tones was the secret of Rubens’ life-like glowing flesh tones.

The sides of chimneypiece retained visible traces of the veining of the painted marbling, lead-white tinted, with red lake and Naples Yellow. The paint covered the original chalk-based filler which had been used to fill the structural joints between the carved stone. These layers of paint and filler are evidence that the mason’s mark would have been over-painted and not left exposed.

Conclusion

The detailed examination of the four chimneypieces created in 1622-1624 has confirmed not only that they were originally painted and gilded, but that they were decorated using expensive materials, such as natural ultramarine and gold leaf, and extremely sophisticated painting techniques which bear comparison with the works of leading artists of the period. The discovery of the use of a common fungus, Brown Witches’ Butter (Exudia Glandulosa), to manufacture a translucent brown pigment used at Apethorpe, may have important implications for the reassessment and attribution of early painted decorations. The chimneypieces at Apethorpe were a crucial component of the 1622-1624 decorative scheme. The rediscovery of the original colours expands not only the technical and aesthetic appreciation of the chimneypieces, but also the understanding of the complex iconography and allegorical meaning of these rare English renaissance masterpieces.
References


Please use the following when citing this paper:

From treatise to gilding practice. Documentary sources on the techniques, materials and decorative processes involved in the Portuguese gilded woodcarving (talha dourada).

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Abstract
In the seventeenth and eighteenth century, the increase in commissions for gilded woodcarving (talha dourada) by Portuguese religious confraternities consolidated the role of the ‘painter-gilder’. This specific kind of artist could work both in the painting of pictorial compositions and in the gilding of retables. This dynamic can be traced in the documentary sources from the period, which loosely encompass two types, namely published treatises or manuals on artistic practice, and the legal contracts signed between the commissioner and the artist. Literary documentation on the subject is scarce and, apart from some research efforts conducted in recent years, rather dispersed. The systematic collection and analysis of this documentation has now resulted in the creation of an organised resource, to be further available for consultation through an online multimedia tool. Such information can now also be used to supplement comparative studies about the differences in the theoretical instructions found in manuals, the results obtained through laboratory examination and analysis of works of art, and the conditions stipulated in the contracts.

Keywords: Gilded woodcarving, treatises, painter-gilder, contracts, techniques, materials.

Introduction
The following paper is the result of the work undertaken as part of a three-year research project, the Gilt-Teller Project. This project is funded by the Foundation for Science and Technology in Portugal, and deals with the interdisciplinary study of gilding materials and techniques in Portugal between 1500 and 1800. In this context, it was proposed to undertake the research of Portuguese artistic treaties on gilding materials and techniques, in order to ascertain to what extent such procedures influenced or mirrored the actual practice of artists from that period. Such information would be compared to the results produced by laboratory analysis of samples collected from gilded wooden, carved retables and other objects, as well as with the recipes found in gilding contracts for retables from that time-frame.

Portuguese art treatises and gilding
A treatise is, by definition, a study or written work on a scientific or artistic theme. It usually includes a certain degree of theorisation on the subject, and information is presented in an organised and systematic way.

The research of Portuguese art treatises raises several problems. In spite of some research efforts conducted in recent years, a lot of questions remain unanswered regarding the methods or materials actually employed by Portuguese artists [1]. This is partly due to the scarcity of bibliographic and documentary sources, where such themes are referred to or explored, and partly due to the geographical dispersion of the research material. This stands even truer in the case of the materials and techniques of gilding.

The problem is challenging because this is a subject that, in the Portuguese context, concerned mostly the everyday practice of artists. There was no immediate concern with the contemporary publication of information on working methods. Rather, these procedures would circulate orally through the workshops, distributed largely within the limits of the relationship between master and apprentice. Empirical knowledge was perfected or preserved, and passed on from one
generation to another in a very close-knit social circuit. Furthermore, we must realise that in a context in which few people knew how to read or write, even fewer people would be able to read a treatise, particularly in a foreign language. This may account for the fact that there are so very few Portuguese works that can be formally considered ‘art treatises’. Most of them are thought to be mere translations of foreign authors, and as such have been traditionally disregarded. This makes us wonder what texts (some probably still unknown) there might be, that could contradict this simplistic image of indigenous treatises.

In the course of our research, a total of thirty-four works were identified and consulted. The dates of these works range from the seventeenth to the twentieth century. Thirteen works included references to gilding, and were arranged in a table, where the respective location and reference number were indicated. The information relating to gilding techniques and materials was transcribed and the corresponding pages noted down on the table. All this information, transcriptions and a table of references will be included in the multimedia tool produced in the context of the Gilt-Teller Project, thus becoming available to public consultation. A copy of the final table is presented below (Table 1).

**From miscellaneous books to gilding treatises**

In the seventeenth century, the national literacy context changed. A new reality emerged and the ‘miscellaneous’ books, also called ‘books of curiosities’, were collated and distributed. Usually handwritten, these manuals were both practical and utilitarian, and consisted of a very diverse collection of notes (prayers, curiosities, notions of astronomy, etc.) for personal use. Sometimes these manuals even contained recipes for painting, illuminating books and other artistic techniques. Such is the case for *Varia Curiozidades*, a miscellany of unknown authorship, dating roughly to the second half of the seventeenth century [Anon 1648-1700]. In it, one can find a recipe for reviving the shine of darkened gold (*Pera fazer, que ouro velho pareça novo*) [Anon 1648-1700, 8]. Another interesting case is that of an anonymous manuscript dating from the seventeenth or eighteenth century, under the title *Miscellanea*, in which one can find a short but detailed recipe on how to produce a ‘shiny gilded or silvered sculpture’ (*Pera pratear ou dourar uma figura lustrosa*) [Anon 1700-1800, 47].

Those works cannot, however, be considered as ‘treatises’, as they have no consistency in their content, nor a clear purpose of transmitting knowledge to others [Afonso and Monteiro 2007, 166]. One important exception is Philippe Nunes’ *Arte, Symmetria e Perspectiva*, dated 1615 [Nunes 1615]. Aiming at the art practitioner (more specifically at painters, whom the author addresses directly) and presented in printed format, this work contains a number of references on gilding techniques, and more importantly, on the preparation of the materials used in the process, such as glue and bole. The fact that the author drew the shared information from his own experience and research, and that he organised and presented it in a systematic way, allows one to believe that this might well be one of the first Portuguese art treatises in which gilding is addressed.

In the eighteenth century, there is no major change in style or content of treatises produced, except in regard to the format of the works. However, many are printed, as opposed to being in manuscript form, which suggests perhaps that these works catered for a wider public dissemination. There is an increase in the references to gilding practices, but, most of these works are still presented as a resource to the ‘curious’ (*os curiosos*), implying that they would be read mostly by people outside the artistic context. Most gilders had no need for such references and their knowledge was empirical. One good example is José Almada’s *Prendas para a Adolescencia*, dating from 1749 [Almada 1749]. This is still essentially a traditional miscellany, but in printed format. It presents a series of detailed recipes on gilding on wooden support, on the *estofado* technique, and on shell gold and purpurine.
Table 1. Table of written works with references of gilding materials and techniques.

<table>
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<th>Location</th>
<th>Reference number</th>
<th>Pages</th>
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</thead>
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<td>Miscellânea. Collecção de curiosidades historicas e literárias, prosa e verso, dos séculos XVII e XVIII, enigmas, agudezas, anedotas, desenhos, etc. [manuscrito].</td>
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<td>SILVA, Francisco Liberato Telles de Castro da (1900) - Algumas indicações sobre a arte de dourar. Lisboa: Typographia do Commercio.&quot;</td>
<td>Biblioteca Nacional</td>
<td>S.A. 27246 P</td>
<td><em>(found under the reference VARELA, José Neto (1901) - Preço corrente de a Favrel Lisbonense: fabrico de ouro e prata em folhas e em pó. Lisboa: Typ. do Commercio)</em></td>
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</table>
A different sort of approach is that of *Segredos Necessários para as Oficinas, Artes e Manufacturas* [Anon 1794]. Aiming directly at the practising artist, it is presented as a collection of technical recipes drawn from existing sources, namely encyclopaedias and ‘the best works so far produced on the subject’ (‘extrahidos da Encyclopédia, da Encyclopedia Methodica, da Encyclopedia prática, e das melhores obras que trataram até agora estes objectos’ [Anon 1794, 1]. There is a clear desire to produce a more scientific oriented work based on creditable sources, as well as a need to collate dispersed information on the subject. The recipes on gilding materials and the techniques involved are numerous and detailed. Also, for the first time, there is a description of a method for removing water gilding from the wooden support (‘Pera tirar o ouro que se acha na madeira dourada a cola’).

A much earlier and less scientific work is Inácio Vieira’s *Tratado de Chirumancia* [Vieira 1710]. Despite its title, it is, in all ways, a miscellany and it also makes reference to a method to ‘clean gilded retablos and panels’ (‘Segredo para limpar retablos dourados e painéis’ [Vieira 1710, 535]. This suggests that contemporary artists were probably asked to perform this kind of procedure.

In the nineteenth century, a vast number of works were published on the subject of artistic techniques, such as dictionaries and encyclopaedias. These were intended for consultation. Some presented descriptive entries on gilding, but due to their own nature (brief and summarised) they provide very little practical information. One would have to wait until 1900 to be presented with a complete work on the subject of gilding. Francisco da Silva’s *Algumas Indicações Sobre a Arte de Dourar* is a pedagogical book for those who wished to pursue the profession of gilder [Silva 1900]. It is also presented as a scientific work, the author being himself an engineer. Even if this work does not belong to the historical period under study, it presents many references to older techniques and one can only wonder where he got the information for such a comprehensive work. The author refers at some point the changes operated in oil gilding ‘in the past 50 years’ ‘o que tem obrigado os nossos douradores, de há cinqüenta anos a esta parte, a estudarem uma produção mais barata’ [Silva 1900, 35]. This detail forced us to consider this book as a valuable source of accumulated experience, which should not be disregarded.

**Gilding contracts. The case of Portalegre**

Parallel with the consultation of treatises and miscellanies, we complemented our work with a survey of historic documentation. The scope was to find gilding contracts and to establish relations with surviving altarpieces. For the Portalegre district (Alentejo), approximately 804 books were consulted at the public notaries’ offices (Cartórios Notariais). These archival documents span a period from the late sixteenth century up to the second half of the eighteenth century, and helped us to understand the concept of ‘artist’ in this particular region of the country. At the end 354 artists could be identified working in the district. Among those, the majority were masons (185), although the names of 32 woodcarvers and 35 painters were also found, the majority also ‘painter-gilders’ [Monteiro 2013, 21].

Compared to the sixteenth century, the commissions for gilded woodcarving (*talha dourada*) multiplied in the seventeenth and eighteenth centuries, thanks to the religious brotherhoods and confraternities. From the patron’s point of view, using the same labour for gilding an altar and painting a ceiling presented itself as advantageous and profitable, within a new logic of attributing multiple tasks to the same artists. Also, many oil painters were driven to seek other activities to ensure their economic survival, entering the military for example, or even working in agriculture. It was not long until they started working as gilders and, at the same time, painting ceilings in ornamental compositions called *brutescos*. The ‘painter-gilder’ activity is inseparable from the woodcarver’s, since they worked, most of the time, as a partnership.

Central to the relation between artists or, even more important, between artists and patrons, was the contract or commission. This regulatory instrument conditioned all the parameters related to artistic activity, leaving little space for creative freedom, even in more recent periods. In fact, the rules imposed by the contracts remained virtually unchanged for centuries, making them the most rigid and stable instruments to control artistic activity.
The contracts for carved wooden and gilded altars are quite numerous in the Portalegre region. However, despite their number, information on the technical details of the artworks is sparse and subjective. The main concern of the patrons was the development of the work itself, for example how many months before the end of the work, how the payment would be made to the artist, what penalties would be imposed if he did not comply with what was determined. Some of the contracts specify all characteristics and also the materials that the artists must use in their work. In most cases, the patrons gave the artist the exact model of the altar that had to be produced, but sometimes the responsibility of the design fell exclusively to the artist, an indication of his growing professional distinction from other craftsmen. Such was the case for Manuel Francisco, a Lisbon carver active between 1698 and 1725 [Ferreira 2009]. At the beginning of the eighteenth century, Manuel Francisco was in Alentejo, in the city of Elvas. He was involved in several works at the same time, which brought him many problems, incurring debts and contractual failures that finally resulted in his imprisonment. Despite this, he was a renowned artist and the author of some significant projects, like the altar of the S. Gonçalo chapel in the S. Domingos convent (Elvas), which was finished in 1718 [2].

Meanwhile, the productivity of the ‘painter-gilder’ surpassed that of the fresco painter, whose activity for centuries had been regarded as the most esteemed of all the painting crafts. The late seventeenth century brought the introduction of the *brutesco*, a key element of the Portuguese baroque and the term ‘fresco painter’ disappears from the documentation in the eighteenth century. The best painters of the kingdom however would not deign to practice this highly decorative technique, even in times when work commissions were less abundant.

One of these painters was Diogo Vogado (1608-1652) who, alongside oil and fresco painting, was also very skilled in the techniques of polychromy, gilding and *estofado* [Serrão 1992, 714]. In 1628, Vogado began a partnership with the ‘painter-gilder’ Bartolomeu Sanchez, and together, they were contracted to paint the ceiling of the Santíssimo Sacramento chapel in the cathedral at Elvas. They were also commissioned to gild the altarpiece and statues [3]. Another example was the ‘painter-gilder’ Manuel de Faria (1612-1672), from Portalegre. From 1665 Manuel de Faria was engaged in the decoration of the main chapel of the church of San Lourenço. In 1669 he signed a contract for the gilding and the painting of figures on the tabernacle [4].

This situation, of painters proving themselves more and more versatile in order to obtain a wider number of commissions, persisted until the eighteenth century. This dynamic is reflected in the increase in gilding references in art treaties from this period, which attest to a growing interest from the public in this art form, as well as to the rise in social and artistic standing of the ‘painter-gilder’.

**Conclusion**

The research of Portuguese art treatises encompassing references to gilding materials and techniques has led us to identify and locate dispersed or unknown information. The information compiled will be made available via an online platform, allowing easy access for public consultation. From the vague, handwritten notes in seventeenth century miscellanies, to specific printed treatises on gilding, one witnesses a growing interest in this art form. This is paralleled in the rising number of gilded woodcarving commissions and the corresponding social recognition of a new kind of artist, the ‘painter-gilder’. Research conducted on gilded woodcarving contracts from this period provides some information on the techniques and materials to be employed, as required by the patrons and commissioners. Such information can now be used to supplement comparative studies, namely between different theoretical instructions found in treatises, the results obtained through laboratory examination and analysis of works of art, and the conditions stipulated in the contracts.
Acknowledgements

This work has been supported by Fundação para a Ciência e a Tecnologia through grants no. PEst-C/EQB/LA0006/2011, no.PEst-OE/CTE/UI0098/2011 and no. PTDC/EAT-EAT/116700/2010 and by FEDER Funds through Programa Operacional Factores de Competitividade COMPETE.

Endnotes

1. One good example is the book *Tratados de Arte em Portugal*, published in 2011, in which a concerted effort was made to gather and analyse all existing information on art treaties in the Portuguese context [Moreira and Rodrigues 2011].


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Please use the following when citing this paper:

The Crucified Bom Jesus de Matosinhos. Technical study and conservation of a medieval sculpture.

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Abstract
The crucified Bom Jesus de Matosinhos, probably dating from the end of the twelfth or beginning of the thirteenth century, is one of the core group of oldest existing sculptures of crucifixions in Portugal. The main goal of this project was the technical study of the sculpture and the conservation of both its structural and its polychrome layers. The study of the support involved the use of X-radiography, Computerised Tomography (CAT), and the collection of samples for radiocarbon dating by Accelerator Mass Spectrometry (AMS). Optical Microscopy (OM) was used to identify the wood species and study the polychrome layers. Portable X-ray Fluorescence (pXRF) and Scanning Electron Microscopy equipped with an Energy Dispersive X-ray Spectrometer (SEM-EDX) were used for the identification of pigments and fillers and the characterisation of ground and polychrome layers. The carved wooden support is made of willow (Genus Salix). The use of this wood species has not been found elsewhere in Portugal as a support for other sculptures, easel paintings or retables. As for the materials identified in the original polychrome layers, the use of kaolinite in the ground layer and lead white with minium for the flesh tones must be highlighted. A significant number of overpaints were applied to the body, hair and the loincloth areas. The different decorative interpretations found mostly on the loincloth are particularly interesting.

Keywords: Polychrome sculpture, Middle Ages, materials, techniques, analysis, pigments, willow wood (Genus Salix).

Introduction
The Bom Jesus de Matosinhos sculpture (204 × 169 cm) is attached to an arboreal cross (233 × 184 cm). The sculpture represents the crucified Christ with his head hanging to his right side and slightly bowed to the front. He is depicted with a straight and thin nose and a short beard, ending in small curls. The ends of his moustache overlap the beard. The shoulder length hair falls on the posterior side of his head. The arms show a slight flexion at the elbows and the hands are represented opened and stretched. The loincloth, tied with a knot on the right side, leaves the right knee uncovered and ends just above the ankle over the left leg. The legs are bent, suggesting the weight of the dead body, and are positioned to the right. The feet are nailed separately to the cross and slightly turn towards the outside (Figure 1).

While unlikely to be so, medieval legend suggests that the Bom Jesus de Matosinhos sculpture was carved by Nicodemos, who assisted Joseph of Arimathea at the Crucifixion [Cleto 1995, 23] [1]. A document dated 1342 refers to this sculpture, placing it in Matosinhos (near Porto) [Cleto 2007, 112]. The document records Mariana Vicente de Baiona’s (from Spain) request to her husband for permission to go on pilgrimage to Santiago de Compostela and to the Bouças monastery, now known as Matosinhos. The document supports the supposition that, at this time, this sculpture was found in a chapel along the pilgrimage route of Santiago de Compostela. The crucifix is currently housed in the parish church of Matosinhos. It is probable that the sculpture was transferred there from the old Bouças monastery when the construction of the church was completed in 1579. The crucifix hangs in the main altar of the church. It was initially
incorporated into the old Ançã-stone retable [Gonçalves 1979, 196]. The current wooden retable, completed in 1733, is a mid-eighteenth century replacement of an earlier seventeenth century gilded version [Brandão 1986, 228].

The crucifix attracts many devout worshippers still today. The Pilgrimage of Our Lord of Matosinhos [Senhor de Matosinhos] was well established in the seventeenth century and remains popular in northern Portugal [Cardoso 1666, 626]. Multiple miracles are associated with this sculpture, conveying fame and popularity to it. It was carried in cortege to calm storms and end plagues [Cleto 1995, 61-62]. Over the centuries its fame has transcended boundaries and oceans. In fact, a sanctuary of the same name can be found in Congonhas do Campo, Brazil.

![Figure 1. The Bom Jesus de Matosinhos. Left: Before conservation. Right: After conservation. © Igreja do Bom Jesus de Matosinhos.](image)

There is no physical information that can be used to determine the authorship of this sculpture. Furthermore, no archival evidence has come to light indicating the origin of this sculpture, nor how it came to the church of Matosinhos. Evidence does suggest that the sculpture was donated to the church either in the thirteenth century by D. Mafalda, Queen consort of Castile (1197-1256), the daughter of D. Sancho I, King of Portugal (1154-1212), or by D. Geraldo Domingues, Bishop of Oporto (c.1285-1321), or a generation later by the latter’s nephew during his patronage as Bishop of Oporto at the beginning of the fourteenth century [Cleto 2003, 72]. The earliest specific mention of this sculpture in the bibliographic sources consulted dates from the seventeenth century. The priest and printer Pedro de Mariz (1150-1615) mentions the crucifix in his principle work Historia of 1609 [Mariz 1609]. A little over ten years later, the sculpture receives further mention by the Spanish painter Francisco Pacheco (1564-1644) [Pacheco 1620, 725]. The work became well known by the eighteenth century and consequently was the focus of an entire book by António Cerqueira Pinto (1679-1744) [Pinto 1737].

The continuous interventions carried out over the centuries have significantly altered, both the original structural composition, and the appearance of the polychrome layers. Interpretation of these alterations by (art) historians has not always been correct. Some of the formal characteristics suggested a dating to the latter end of the thirteenth or the beginning of the
fourteenth century [Barroca 2002, 185]. However, other features resembling twelfth-century Burgundian sculptures, such as the size of the loincloth that covers almost all the legs and the feet nailed separately to the cross, indicated a much earlier date [2].

The initial goal of this study was to stabilise the wooden structure and to identify the materials and techniques used to construct the sculpture. However, when studying the sculpture more closely, it was clear that the conservation condition was much more serious than first anticipated. A more in depth and integrated conservation treatment permitted assess to the reverse, which allowed the observation of crucial information regarding past restoration campaigns.

Figure 2. X-Radiographic image of the head. © A. Maniés.

**Analytical techniques used for investigation**

X-radiography and Computerised Tomography (CAT) were used to identify the construction techniques employed and the later additional elements. Portable X-ray Fluorescence (pXRF) was used to identify chemical elements in the paint surface. Micro samples were collected from different polychromed areas and cross-sections were prepared for observations with Optical Microscopy (OM), allowing the identification of the different layers as well as the colour, size and shape of the constituent particles. The elemental composition of paints was interpreted based on the elemental analysis undertaken with a Scanning Electron Microscope equipped with an Energy Dispersive X-ray Spectrometer (SEM-EDX). Micro chemical tests were used to detect the presence of carbonates in the ground layers and histochemical tests were used to characterise binders in both the paint and ground layers. The wood species used for the sculpture was identified using Optical Microscopy. Radiocarbon 14 by Mass Spectrometry was used to provide a terminus post quem for the wooden support of both the sculpture and the rod of the cross.

**Original material and construction techniques**

**The support**

The cross to which the sculpture is attached is constructed by using two different species of wood. The vertical rod is carved from horse chestnut while the horizontal cross arms are composed of oak. Two iron staples were used to join the two beams at the intersection. The
sculpture itself was nailed to the cross with two wooden pegs inserted through the hands and two iron staples inserted through the stigmata in the feet. Five additional iron bars, driven through the loincloth (three to the right of the figure and two to the left), provide extra support. Medieval precepts seem to have been followed to construct the figure. Three sections have been used: one for the body and two for the arms [Baudry 2006, 161]. The arms are attached to the main section by wooden tenons, elliptical in shape, that join at the shoulders. The tenons are locked in place by wooden pegs. The reverse of the sculpture is hollowed-out from the shoulders to the knees. This technique reduces internal tension within the structure of the trunk as the wood loses its moisture content. The marks left by the tools used to hollow-out the wood are visible.

The wood selected for the figure is willow (Genus Salix) [3]. This wood was not typically used by Portuguese artisans. It has not been found in any contemporary sculptures, panel paintings or retable structures. However, this wood was commonly used for sculptures in Italy and France of the same period [Frosini 2005, 29]. This suggests that this sculpture might have been imported.

Changes to compositional elements and missing elements were identified using images produced by X-radiography. A well-defined line overlapping the hair-line in the centre of the forehead can be clearly seen. This line corresponds to the position of a crown, now lost. Further lost elements could also be identified, such as a fragment of the upper right ear. This fragment was revealed once the later applied plaster and canvas alterations were removed. A close study of the face in the X-radiograph indicates that Christ was initially represented with his eyes closed (Figure 2).

Computerised tomography enabled a more detailed picture of the wooden support, its condition and the construction process. Placement of joints, attachment systems, the characteristics of the wood used and its condition could be determined. Splits and cracks resulting from the movement or shrinkage of the support were identified, as was the extent of insect damage. The growth rings and position of knots are clearly visible. The rings do not show a regular growth pattern, registering many deviations resulting from the growing conditions of the living tree. The CAT scan also revealed that additional elements were inserted into the three main sections composing the structure. The knot in the loincloth consists of an additional wooden piece inserted into the main block and held in place with a nail. Additional smaller wooden sections were inserted into the abdomen region above the legs. The divergent orientation of the wood grain is clearly visible.

Figure 3. CAT transversal image taken at the level of the knot in the loincloth. © A. Maniés.
evident. One further wooden addition can be found in the right heel. Here the orientation of the addition follows the same direction of the main block (Figure 3).

The radiocarbon dating was carried out using Accelerator Mass Spectrometry (AMS). The results indicated that the tree used to construct the sculpture has of a \textit{terminus post quem} felling of 690 +/- 30. The corresponding \textit{terminus post quem} for the cross would be 1210 +/- 30 \cite{4}. The discrepancy between these dates posed additional questions. Making allowances for a margin of errors for the felling date (+/- 30 years) and the necessary time to season the wood, the date derived would appear consistent and acceptable for this type of arboreal cross. However, the results pertaining to the figure need re-evaluating. The dimension of the sections, the nature of the support and the formal aspects in combination mean that such an early date is not feasible. Thus how should these data be interpreted? One suggested explanation poses the idea that the figure was (re)carved from an older section of wood that had sacred connotations associated to it, and was thus selected for such a holy figure. However, this hypothesis does not take into consideration the conservation condition of the section analysed: could willow, a medium density wood, that has been subjected to wood boring insect damage, still be well-preserved at that age? Might it be that this wood was the result of reutilisation? Or, despite the care involved in collecting the wood sample, could it have been contaminated? Did the sample contain residues of a film forming material applied during a past treatment, or traces of the combustion of candles? The presence of a contaminant would alter the resulting date either way.

\textbf{Ground and original polychrome layers}

Preparation layers were applied to the entire surface irrespective of covering polychrome effects. Samples were removed from the flesh and loincloth areas. In most of the samples the SEM-EDX element distribution maps suggest the presence of kaolinite (\(\text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4\)), which probably was the material used in the original ground.

Histochemical tests applied to cross-sections were carried out to characterise the binding medium. A positive reaction to acid fuchsin, observed using OM, indicated the presence of a binder with hydrophilic characteristics in the original ground layer, probably animal glue.

In-situ observation or analysis of the original polychrome was impeded due to the extensive overpaints and the respective composition. For the most part, the high atomic elemental number and density of the overpaint prohibited analysis of original layers by pXRF. However, the identification of older coatings, through lacunae in upper layers, was possible in the frontal area of the head. Moreover, the removal of a later applied parchment sheet from the reverse of the sculpture revealed original polychrome layers. Here the original yellowish flesh tones are visible in contrast to the later pinker colour. This sequence is common to all samples, collected from abdomen, arms, head and the left foot. SEM-EDX analysis was carried out on the cross-section samples. Results showed the presence of lead (Pb) in the original flesh tones, suggesting the use of the pigments lead white and/or minium, and of iron (Fe) in the brown hair, indicating the use of earth pigments such as umber. The loincloth was originally painted green and was decorated with foliage motifs, applied in grey, resembling the stem of the \textit{fleur-de-lis} or vine branches. Here the elemental analysis determined the presence of lead (Pb), iron (Fe) and manganese (Mg), which correspond to the use of the pigments lead white and green earth.

\textbf{Subsequent alterations}

As it is expected of a sculpture of this age, numerous past restorations were identified. Structural repairs and aesthetic treatments were evident.

\textbf{Support}

Various formal changes have occurred to the sculpture over the centuries. Adaptations to attributes have occurred and structural issues have been resolved. The shape of the upper part of the head, originally covered by a carved crown (now lost), was altered to accommodate the later
addition of a natural hair wig. Excluding the arms, which were carved separately, the whole sculpture was made from the same trunk. As a result, there is a longitudinal crack separating the lower legs of Christ. This damage was treated in the past by sawing the wooden trunk crosswise, just below the pelvis area, before the crack could extend through the whole block of wood. The resulting lower and upper sections were rejoined using seven metal pins to clamp the two halves of the body together. A further clamp provides stability to the separated legs. The metal clamps appear to be a replacement for an earlier treatment as four holes for wooden pegs (no longer present) are present on both sides of the saw cut. Further structural strengthening nails were used to reinforce the joints between both arms and the body. The hollowed-out reverse of the sculpture was also adapted in the past to counteract the damage caused by wood boring insects. The hollowed-out area was filled with plaster (consisting of gypsum mixed with animal glue) and subsequently covered with firstly cork sheets and a sheet of parchment at the surface. Nails were used to secure this addition. Additional parchment strips were found attached to the upper sections of the arms. Again the intention was probably to reinforce the damage caused by wood boring insects. A more recent adaptation was added in 1967, when a brass strip was applied to reinforce the attachment of the sculpture to the cross (Figure 4 and 5) [5].

![Figure 4. Left. The surface of the reverse is visible after removing the cork and parchment sheet covering the hollowed-out reverse. © A. Maniés.](image1)

![Figure 5. Right. The surface of the loincloth is visible after removing the canvas strip. The separation of the main trunk between the body and legs can be observed. The two sections are held together with metal clamps. © A. Maniés.](image2)

**Overpaints and added restoration materials**

Close examination of the surface of the sculpture and cross-sections, removed from representative areas, determined the extent of past aesthetical treatments. The elemental distribution maps obtained by SEM-EDX support the visual evidence. The flesh tones were repainted at least five times. A further layer of overpaint was identified covering the feet and the bare right leg. The hair and beard were also repainted in five different phases, always in shades of brown, although the last repaint is lighter in tonality. The elements identified by SEM-EDX were lead (Pb), titanium (Ti), barium (Ba), zinc (Zn), mercury (Hg) and manganese (Mg). These
elements can be associated with pigments such as lead white, minium and vermilion used in earliest repaints and titanium white and lithopone used in later overpaints.

The head and neck areas were also remodelled in the past. A layer of plaster containing sawdust over which a layer of canvas was applied, covered the head and part of the neck. These additions covered almost entirely the ears. The result imitated hair. Traces of original gilding were found on the hair when the crudely applied plaster was removed.

The long loincloth was partially covered by a piece of canvas, which was loose at many points and had been reattached in other areas with small iron nails. After removing the canvas, five different repaint phases were identified.

The many aesthetic additions distorted the illusionistic nature implied by the carving and created new forms. Christ’s torso, ribs and abdomen now appear flat and new details have been added over the centuries. Pinto describes the position of the stigmata on the left thorax but makes no mention of the other wounds, which can be seen at the head, shoulders and knees [Pinto 1737, 78]. Thus, it seems likely that this re-imaging was created after 1737 (Figure 6).

Figure 6. Left: Cross-section (OM) showing the stratigraphic layer build-up. Right: An SEM-BSE elemental distribution contrast map of the same cross-section. © A. Maniés.

Conservation condition before treatment

The support

Structurally the sculpture was very unstable. Wood degradation caused the side elements, fixing the sculpture to the cross, to loosen. Insect damage to the reverse, creating a spongy effect, reduced mechanical resistance. The iron clamps and nails were oxidised and completely corroded. Joints between the main trunk and appendages were deficient due to the advanced oxidation state of the iron nails. Movement at these junctions propagated damage through the polychrome layers. Shrinkage may have produced the crack in the longitudinal section separating the legs. Cracks and splits were also present in the main trunk. The most severe cracks run from the left side of the neck to the chest and a split is present between the index and middle finger running to the wrist. The latter was previously repaired using both a sheet of parchment and wire to reinforce the two opposing pieces.

The sculpture used to be dressed with an embroidered silk mantle for festivities. The mantle was secured with pins and small nails. This mantel has not been used since 1993 when the conservation of the chapel was undertaken.

Ground and polychrome layers

The adhesion of the ground layer to the support was inadequate in some areas. Later restorations, such as the plaster applied beneath the parchment layer, were also deficient and loose. Losses are also present in the superficial layers. There are numerous lacunae in the
loincloth and in the head areas. Lacunae are of various different depths. In some holes it is possible to see the support and in other lacunae the ground or earlier polychrome layers. Moreover, some losses to the superficial layers can be directly related to the execution of a mould when, in 2005, a reproduction of the sculpture was commissioned. The scalpels used to remove the mould additionally caused incision lines along the body.

The polychrome layers presented various other damage or degradation patterns. The upper repaints are discoloured or have developed a different tonality. The twentieth-century repaint of the legs and feet, containing titanium white, is more yellowish compared to the upper incarnation [Seccaroni and Moioli 2002, 119]. Further evidence of damage to the polychrome layers can be related to veneration practice. Parishioners had access to the tribute and were allowed to touch the sculpture. Wear and abrasion damage is present in the arms and legs.

![Figure 7. Original decorative patterns in the loincloth area that had been covered by a later applied canvas piece.](image.png)

**Conservation treatment**

*Structural repairs to the support*

An extensive and complete conservation treatment was planned for the sculpture. It was initially removed from the cross to gain access in the round. The previous restoration materials, such as the parchment sheet, cork and plaster layers, were removed from the head, loincloth and hollowed-out reverse. The parchment and cork were considered integrated elements of the conservation history of the object, and were retained as such. Consolidation of the wooden support was then of primary importance to reinstate structural stability. An acrylic copolymer resin dissolved in organic solvents was selected as consolidant for this task. Local consolidation of the detached superficial layers was implemented using a proteinaceous animal glue. Once consolidation was complete the parchment and cork, covering the hollowed-out reverse, were replaced and adhered with a proteinaceous fish glue, selected due to its lower jellification temperature. The canvas covering the loincloth was not replaced, because it had covered original decorative patterns (Figure 7).
Returning structural stability to the joints was important. Finding an appropriate long-lasting system was challenging. A life-size scale model in poplar was constructed in order to implement initial experiments. After testing, carbon fibre rods, fixed in place using an epoxy resin were chosen to stabilise the joint between the body and legs. These were inserted into the two small pre-existing channels previously used to house the metal clamps. The wood was isolated with an acrylic copolymer resin prior to the application of the new reinforcement system. Losses in the wooden support in this area were filled using thin wedges of poplar wood adhered with a polyvinyl acetate water-based emulsion. Another system was designed for the attachment of the arms to the main section. The missing original wooden pegs were replaced with treated poplar wood and glued with a polyvinyl acetate water-based emulsion. The iron pins were removed and replaced with carbon fibre rods fixed in place with an epoxy resin. The crack in the right hand was reinforced by adding two internal dowels made of poplar, which were adhered in position with a polyvinyl acetate water-based emulsion. Surrounding gaps in the support were filled with wooden wedges of the same wood species, except for the large crack in the neck, which was filled with balsa wood.

\[\text{Figure 8. The new stainless steel support system attached in the hollowed-out reverse. }© \text{ A. Maniés.}\]

**Aesthetic treatments**

Dirt was removed from the surface using an aqueous system adjusted to appropriate pH and conductivity values. This system worked efficiently where there was no varnish present. Organic solvents were used to remove the oxidised varnish layer. These were selected after rigorous tests according to their appropriate solubility parameters. Solvents were gelled with polyacrylic acid in order to increase effectiveness and efficiency.

A fully integrated aesthetic treatment was proposed. Thus, all lacunae were filled to recreate a uniform surface level and were retouched using chromatic reintegration based on tints of the surrounding area in order to distinguish these from the existing polychrome surface. Deeper lacunae were filled with a paste made of purified cellulose fibres and calcium sulphate, bound in an aqueous acrylic dispersions with the addition of a small amount of water. This paste was easy to work with and level surfaces could be achieved without difficulty. The fills remained slightly
flexible after drying with an opaque but regular surface. Shallower lacunae were filled with a mixture of calcium sulphate and animal glue. Pigments bound in gum Arabic were used to implement the *trattegio* technique. An acrylic copolymer resin dissolved in organic solvents was used for the final protection film.

Decisions to retain, replace, or reconstruct other embellishments, such as the wig and the crown were made in consultation with a commission consisting of all stakeholders in the project, namely the conservators, the priest, art historians and a representative of the General Directorate for Cultural Heritage (Direção-Geral do Património Cultural, DGPC). It was decided to return to a medieval appearance to the sculpture. Thus the wig was not replaced and a new crown, and silver halo, was constructed in plywood and decorated with gilt silver, which was darkened to integrate into the exhibition surroundings.

A new system was required to securely fix the sculpture to the cross. While the cross is displayed vertically in an upright position, the sculpture was meant to hang at an angle to the cross. The weight distribution and position of the sculpture was key in the design of the new system. A stainless steel framework was constructed, that was attached to the upper carved area and diagonally at the top of the hollowed-out section on the reverse. The framework allows for the inclination of the sculpture and can be used to align the sideways position of the sculpture. The attachment to the sculpture consists of five stainless steel threaded rods 12 mm in diameter connecting to nuts inserted into sockets in the cross. Holes were punched into the cork and parchment to allow the rods to pass through (Figure 8).

**Conclusion**

This project aimed to contribute to the understanding of medieval sculptures. The technical study of *Bom Jesus de Matosinhos*, combined with the radiocarbon dating and art historical research, suggest that this work may have been constructed towards the end of the twelfth century or the beginning of the thirteenth century. This also assumes that the cross and the sculpture are coeval. The constructive process is similar to methods used to produce other sculptures depicting the Crucified Christ of this period found outside Portugal. Few contemporary examples of this type of sculpture exist in Portugal. The use of willow as a wood species has not been documented previously. This suggests that the sculpture may have been imported. The sculpture’s importance as an object of veneration has resulted in the periodic application of ‘fresh colours’, distorting the original appearance but reflecting on changes in taste in different times (Figure 1). The conservation treatment included a stabilisation to the sculpture that had not been carried out for generations. Furthermore, decisions taken during the conservation process has given the sculpture an appearance closer to its medieval conception, especially in the head and loincloth areas. These decisions could not be taken lightly due to the ongoing use of the sculpture as an object of devotion and reverence.

**Acknowledgments**

The authors would like to thank Father Manuel Mendes for allowing this work to be carried out; to the Matosinhos City Hall, represented by Guilherme Pinto, for the financial support; to Isabel Dias Costa and Adriana Amaral - DGPC, Joel Cleto, Mário Barroca, Álvaro Sequeira Pinto, Arlindo Silva, Frederico Henriques Vitor Teixeira, Farinha dos Santos - Sika, Daniel Quinta - Iperforma, for contributing to the debate regarding conservation decision making; to António Candeias, José Mirão and Luís Dias – Laboratório HERCULES, Stefan Alves and Jorgellina Carballo - UCP, João Pereira - LabMed, for the analytical results.

**Endnotes**

1. It was believed, in the medieval period, that Nicodemos carved a number of sculptures representing the crucified Christ, including *Volto Santo de Lucca*, the *Santo Cristo de Burgos*, and *Cristo de Ourense*.
2. These include Le Christ Détaché de la Croix (R.F. 1082) in Musée du Louvre, Paris and the Burgundian Christ, Museo dell’Opera del Duomo, Pisa.

3. The examination and identification of the wood species was carried out by Dr. José Pissarra at the Faculdade de Ciências, Universidade do Porto, in January 2012.

4. The before present date (BP) is 1950. Thus, the referred numbers must be deducted from this year. Sculpture: 1260 +/- 30 BP and the chestnut rod of the cross from 740 +/- 30 BP. Resulting in terminus post quem of 690 +/- 30 AD for the sculpture and 1210 +/- 30 AD for the cross. Analysis was carried out by Beta Analytic [4985 S.W. 74 the Court, Miami, Florida 33155 -Tel: (305) 667.5167 - Fax: (305) 663-0964 - Email: beta@radiocarbon.com.

5. The priest permitted the sculpture, on request by the parishioners, to take part in the procession celebrating the 50th anniversary of Fatima’s Appearance. To ensure stability during the festivities the brass strip was added. Information provided by the church sexton Mr. Domingos Martins.

References


Cardoso, 1666. Agiologia lusitano dos santos e varões ilustres…, Lisbon: Officina de Antonio Craesbeeck de Mello.


Pinto, A. 1737. História da Prodigiosa Imagem de Christo Crucificado que com o titulo de Bom Jesus de Bonças se venera no Lugar de Matosinhos. Lisbon: Oficina de António Isidoro Fonseca.

Material List

Paraloid® B67 (Acrylic Copolymer)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Paraloid® B72 (Acrylic Copolymer)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Shellsol® D40 + Shellsol® A (Aromatic hydrocarbons)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Rabbit Skin Glue (Proteinaceous animal glue)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Salianski Kremer Isinglass Glue (Proteinaceous fish glue)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

SikaWrap® 230-C/45 (screen carbon fibers)
Sika Portugal
https://prt.sika.com (23.02.2016)

Sikadur® - 330 – (Epoxy resin)
Sika Portugal
https://prt.sika.com (23.02.2016)

Plextol® B500 (Emulsion of ethylacrylate/methyl methacrylate copolymer)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Carbopol® EZ 2 (2-polyacrylic acid, self-dispersing)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Ethomeen C25® (100%, fatty amine from coconut)
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Ethyl Alcohol
Kremer Pigmente GmbH & Co. KG
http://www.kremer-pigmente.com (23.02.2016)

Please use the following when citing this paper:

A sixteenth-century tabernacle in Flanders with non-Flemish sgraffito decorations.

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Abstract

A tabernacle is displayed on a wall of the Onze-Lieve-Vrouwekerk in Dendermonde (Belgium). Its provenance is unknown. The original appearance of the tabernacle had become obscured over time, which became clear after the start of the now completed conservation treatment. The accompanying study gave a unique insight into the construction and the build-up of the surface layers. Treatment in the conservation studio allowed careful observations of the constituent materials, including micro-chemical and microphysical research. This paper will focus on the decoration-technique of the object, which can be defined as sgraffito. The findings allowed a reassessment of the provenance and dating of the tabernacle.

Keywords: Polychromed wooden sculpture, sgraffito-technique, tabernacle, altarpiece, sixteenth-century European art, conservation-restoration.

Introduction

The subject of this paper is the altarpiece, which can be found in the side chapel of the Onze-Lieve-Vrouwekerk in Dendermonde, Belgium (Figure 1). This liturgical object was studied and restored in the conservation studio of polychromed, wooden sculptures at the Institut Royal du Patrimoine Artistique (KIK-IRPA) in Brussels between 2009 and 2012. The extensive conservation treatment provided the opportunity to study and research the artwork further. The investigation looked into the provenance and authenticity of the altarpiece and its separate wooden elements. Information about the former whereabouts was scarce. Before the start of the project, it was thought to be of French origin and made in the eighteenth century [1]. However, by studying the stylistic and material-technical characteristics of the decorative layers closely, as well as other aspects, it was possible to prove wrong this assumption.

The altarpiece consists of a wooden case, which is composed of numerous wooden parts (measurements 93.0 cm × 146.2 cm × 30.5 cm). A small door, with a representation in low relief, is located centrally in the sculpted front side. On either side of this are two small freestanding sculptures placed in niches. These figures are positioned in an architectural setting with columns, framework and many other details executed in a renaissance style. The Resurrection of Christ, the four Apostles and several classical themes are depicted. But these sculpted elements on the Dendermonde tabernacle are no more than remnants. The original form and purpose of the altarpiece is not visible anymore due to changes and additions made over the lifetime of the artwork. Its current function can be interpreted as tabernacle and a tangible object of commemoration. The inscription ‘IN MEMORIAM DNI DANIEL E. SCHELLEKENS (1881-1961) FAMILIA D.D. 1973’ is visible on the upper border. This Belgian, influential and wealthy Schellekens family had bought the altarpiece in the first half of the twentieth century in their own country.

Sgraffito patterns on the altarpiece

The altarpiece is decorated with a sgraffito decoration (Figure 2). A distinction existed in the sixteenth century between the profession of painter and decorator of carved surfaces. This distinction is evident in contemporary documents. The embellishment of sculpted altarpieces was carried out by other hands than a painter. Although both artisans worked with paint, there is little distinction in the artistic quality of the decorative layers produced [Bruquetas Galàn 2002, 381-388]. Sgraffito applications would have been carried out by a decorator of carved surfaces.
The subjects which could be depicted using this technique vary between relatively simple or abstract and figurative with exuberant details. The colours of the patterns and background are often extremely bright. Grotesques, geometrical forms and floral motifs were frequently used. Contemporary engravings and so-called sample books, such as Solis’s *Enciclopedia de la Ornamentation, Arabescos* of 1541, are often mentioned as sources for the selected decoration patterns [Bartolomé García 2001, 25-29, 78-192, 230-235, 359-363].

![Image](https://example.com/image.jpg)

**Figure 1. Tabernacle of the Onze-Lieve-Vrouwekerk in Dendermonde. Before conservation treatment. © KIK-IRPA Brussels**

The wooden surface of the altarpiece from the Belgian Onze-Lieve-Vrouwekerk had been covered with layers according to the presumed traditional method of *sgraffito*, which corresponds with the texts of Pacheco’s *Arte de la Pintura*, as published in Sevilla in 1649 [Pacheco 1649, 452-466]. To create a *sgraffito* pattern the artist had to start with gilding the complete surface, covering the wooden sculpture with multiple layers of gypsum and bole and subsequently with gold leaf. After the gold was burnished, one or more layers of paint or lacquer were applied on top of the gilding by brush. The binding medium of the pigment based paint was most probably egg yolk. These coloured layers were then partially scraped off, revealing the underlying gold again and creating thus even more fanciful decorative motifs. The chosen predominant patterns were often surrounded by a background filled with incised parallel stripes. The difference between the colourful, matte paint and the shiny gold resulted in contrasting light reflections and in an almost three-dimensional surface texture. Being applied often on parts of the sculptures which represent garments, the *sgraffito* technique can be interpreted for example as an imitation of textile fabrics with interwoven golden threads.

However, interpreting the exact build-up of the layers on the tabernacle in Dendermonde proved to be more difficult than initially presumed. The surface appeared to have been redecorated several times throughout history. But not all sculpted components of the altarpiece are covered with the same amount or with the same type of layers. It was not always possible to date the individual decoration phases, although some indicators are present. Some of the wooden elements of the altarpiece were attached at a much later stage, and therefore also the decorative layers are of a later date. Some pigments and dyes are known to be used by artists very early in the history of art and can be defined as possibly authentic for that reason [Eastaugh et al. 2008].
And of course the chosen decorative motifs, which correspond to prevailing stylistic developments, can be dated in a certain period.

**Sgraffito patterns on a micro-level**

It is not known why the beautiful first or earliest sgraffito decorations were covered up during a second decoration campaign, executed presumably even shortly after their completion. The original appearance of the altarpiece seems lost. On a micro-level, small areas in which the underlying layers can be observed, are present. An example is the hair-colour of one of the apostles, which was originally white instead of dark brown. Samples were taken and different optical and analytical techniques were used to analyse these. Research was carried out by means of Optical Microscopy (OM), Ultraviolet Fluorescence (UV), X-radiography, Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM-EDX), Raman micro-Spectrometry (MRS), High Performance Liquid Chromatography (HPLC) and Fourier Transform Infrared Spectroscopy (FTIR).

No new information was found studying the complete surface of the altarpiece under UV light. In fact, the surface did not fluoresce at all. The x-ray images gave a clearer impression of the original appearance of the altarpiece of Dendermonde. The difference in absorption and transmission of the x-rays between the gold and the pigments, resulting in a contrast differential, makes it possible to visualise the striped pattern of the underlying decorations. Since gold is not a heavy metal element, the underlying decoration layers are not screened out by the upper gilding. The x-radiography examination showed that the whole sculpted surface of the altarpiece was originally covered with sgraffito patterns, with the exception of a few architectural elements and the flesh-coloured parts of the represented figures. The sculpted elements, which now seem to be simply gilded, appear to be covered in this decoration technique in a lower level of surface layers. Even more surprising is that older sgraffito motifs are present under the areas in which the sgraffito decoration is still visible as top layer. The x-radiographs clearly show a stylistic difference between the visible top and hidden lower layers of sgraffito. The lower layer has a more refined border decoration underneath the stripe and arabesque-like patterns on the garments of two of
the apostles. On the third apostle these underlying patterns did not become visible and the fourth
apostle, which has quite different characteristics, is decorated with only one *sgraffito* decoration.

It is peculiar that only two of all taken samples showed some resemblance to each other,
confirming the heterogeneity in the build-up of the decorative layers. Generally, the cross-
sections of the samples demonstrate a repetitive layer build-up with a relatively thick preparation
and dark red bole layer, followed again by a preparation and bole layer. Each stratum consists of
many sublayers. Through SEM-EDX it became clear that gypsum as well as chalk were used in
the preparation layers on different elements of the altarpiece. Histochemical tests indicate the
presence of proteins in the preparation layer, which could be explained by the use of animal glue
by the artist.

By studying and combining the results of stereo-microscopy, SEM-EDX, MRS, HPLC and
FTIR, conclusions could be drawn about the presence of pigments and dyes amongst other
things in the *sgraffito* paint, such as lead white, azurite, natural malachite, indigo, vermilion, brazil
wood and red lake [Sanyova 2012]. Interestingly, the eldest, now hidden *sgraffito* decoration on the
garments of the apostles appear to have dyes as transparent colouring substance, while the
second, visible *sgraffito* decoration is matte and pigment based. Moreover, the paint consisting of
pigment particles is built up by two separate layers, which have a different colour and sometimes
are glazed. This building of layers raises questions about the making process, since drying times
are an important factor while incising the patterns. However, further research is still needed on
the exact composition of some pigments, lacquers and binding media.

**Conservation and restoration**

The understanding of the layer build-up and the material-technical characteristics of the
decoration was exceedingly important during the decision-making process preceding the
conservation treatment. An interesting question was which layer or which phase in its realisation
and alteration history would be the reference point during treatment. Each layer has its own
meaning. Going back to one single moment in history was however not achievable, due to the
strong adhesion between the paint of the underlying *sgraffito* decoration and the substructure of
the second gilding. Moreover, original material was missing and not retrievable anymore.

The presence of the most divergent materials and binding media caused difficulties in conserving
and restoring the decorative layers. The water sensitivity of the gilding, the disparity in surface
level, the inadequacy of binding medium concerning several *sgraffito* colours and the sometimes
failing cohesion in-between the preparation layers were complicating factors during cleaning.
Before conservation and restoration, the tabernacle of the Onze-Lieve-Vrouwekerk was covered
with a dark layer of mostly surface dirt. Although the well-known patina discussion was taken
into account, the decision was made to remove all dark coloured layers on top of the flesh tones,
garments, gilding and *sgraffito* layers. The colours of the *sgraffito* paint, the sheen of the gilding and
the details of for example facial hair had been hardly readable anymore. Initial cleaning tests were
carried out. Local stains of materials of all different kinds, the countless craquelure through all
paint and preparation layers and therefore the minimum quantity of stable testing area were the
main reasons that laborious mechanical action, using scalpel under microscope magnification,
was chosen to remove the dirt.

Before cleaning was executed, an extensive consolidation treatment was carried out [Mercier
2003, 17-29]. At a later stage, also larger wooden elements of the altarpiece, which had detached,
were re-glued again in position. Remains of previous treatments or repair work were adjusted to
the newly restored appearance. Most of the arms or hands of the apostles were later
replacements and had suffered new damage already. Missing fingers were reconstructed and
retouched. Large lacunae in the surface, which are showing the original underlying *sgraffito*
decorations, were not filled. Fortunately woodworm holes could not be found.

The end result of the treatment is an altarpiece, which can fulfil its function of liturgical object,
without being endangered in its subsistence by detaching wooden or polychrome fragments.
(Figure 3). Also the aesthetic appreciation of the decorations is possible again. Although the now visible top layers of each sculpted element of the altarpiece are maybe not contemporary, the regained colours and gloss of the sgraffito decorations give the viewer a fair impression of the splendour of the sgraffito technique.

Concluding remarks

The many differences in respect of build-up and composition of the layers on the different wooden components of the altarpiece could be an argument to conclude that these sculpted parts originally did not belong together. The presence of dissimilar types of wood, different raw materials for the preparation layers and the stylistic disparity between the physiognomic appearances of the statuettes confirm this hypothesis. For example, the little sculpture of the apostle at the right extremity did probably not form part of the altarpiece. Furthermore, even the structure or form of the altarpiece itself is not authentic, since it does not resemble comparable contemporary sculpted altarpieces from either southern or northern Europe. Most likely, the altarpiece was only a piece of a larger one. Considering the possibility that the altarpiece of Dendermonde was originally larger in size, comparisons between this object and the large Spanish altarpieces from the sixteenth century demonstrate great similarities. In addition to specific decoration methods and patterns, also the iconography, style and positioning of the sculpted elements are almost identical.

Of course the sgraffito technique was not exclusively used in southern Europe. Also in northern Europe, most notably in Mechelen, Brussels and Antwerp, sgraffito decorations were applied on wooden sculptures [Pévier-D’Ieteren et al. 2000]. But these northern statues have a physiognomy, which does not match the appearance of the sculpted figures of the altarpiece in Dendermonde. Moreover, only on certain parts of these Belgian sculptures, such as the border decorations on the garments, sgraffito patterns were applied.

In conclusion, by studying closely the decorative practice in different countries, it was possible to recognise most parts of this tabernacle in Flanders as non-Flemish. The sculpted components of the altarpiece can be situated in Spain and dated individually around the second or third quarter

Figure 3. Tabernacle of the Onze-Lieve-Vrouwekerk in Dendermonde. After conservation treatment. © KIK-IRPA Brussels

of the sixteenth-century. The current structure is however, probably an assemblage of the twentieth century.

Acknowledgements
The postgraduate program ‘Conservation and Restoration of Cultural Heritage’ at the University of Amsterdam (UvA) is concluded by an internship and a thesis. The subject of this final research has been the above described tabernacle from the Onze-Lieve-Vrouwekerk in Dendermonde, Belgium. In collaboration with other conservator-restorers, I have studied and restored this object at the Institut Royal du Patrimoine Artistique in Brussels (October 2011-May 2012). I would like to thank with all my heart head Dr. Emmanuelle Mercier and all staff members (Fanny Cayron, Christine Cession, Ingrid Geelen, Erika Rabelo, Delphine Steyaert, Sandy van Wissen) of the Polychromed Wood Studio at KIK-IRPA, including the people involved at the departments photography (Marleen Sterckx), x-radiography (Catherine Fondaire) and the analytical laboratory (Jana Sanyova, Cécile Glaude, Louise Decq), who made it possible for me to do this research.

Endnotes
1. Findings resulting from correspondence with the representatives of the church and the archive of Dendermonde and with the former owners, the Schellekens family.

References

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Abstract
This paper reports on a work-in-progress of two seventeenth (or eighteenth) century polychrome sculptures, Santa Rita and Santa Cecilia that belong to the Museum of Évora. A formal analysis of the decorative patterns and punchwork used in the garment’s decoration (estofado) was executed and both sculptures showed similarities. This study aims to compile data that may lead to a possible attribution to the same workshop, or to the same sculptor or painter-gilder, through the comparison of material characteristics. Focusing on the stratigraphies of the estofado decoration, characteristics were identified through Optical Microscopy (OM), Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM-EDX), Fourier Transform Infrared Spectroscopy (FTIR) and Raman Spectroscopy. The principal findings demonstrated that the used techniques and the major or minor components of the materials present in the different strata, are exactly the same in both sculptures. This reinforces the proposal that both sculptures have been executed by the same workshop or partnership.

Keywords: Polychrome sculpture, estofado, materials, techniques, baroque.

Introduction
Research into the workshops, partnerships (between sculptors, painters and gilders) and regional specifications in the production of baroque, wooden, polychrome sculptures in the region of Évora, Southern Portugal, is still at an initial stage. The information available on the materials and techniques used in the production of wooden sculpture in this country in that epoch is also
sparse [Barata 2007, 23]. Few polychrome sculptures are documented and most remain unattributed, due to the lack of a systematic archival research. The original locations of sculptures are unknown and an integrated research between art historians, conservators and material scientists is limited [Ferreira-Alves 2002, 17]. In the last few decades, studies on this subject were executed in other regions of Portugal, while in Évora the Archdiocese carried on a systematic inventory of their patrimonial property, which includes a vast collection of polychrome sculptures.

One of the greatest difficulties of attribution studies of polychrome sculpture is related to the number of different techniques and of artists involved in its execution. The artistic professions in this epoch were well-defined, legislated and limited to the work that each one could execute. Transgressors of the hierarchy received harsh fines, public punishment and even jail if they did not comply the regulations [Lino and Silveira 1969, 10-18]. The activity of the sculptor was limited to the carving of wood, while the preparatory layers, the gilding process and polychromy were performed by the painter, the gilder, or a range of professionals with different skills [Espinosa 2002, 40]. It is known that occasionally some sculptors were also allowed to do the work of gilding and polychromy [Espinosa et al. 2002, 40], but there was a tendency towards partnerships between sculptors and painters. Some renowned painters as Zurbarán or Francisco Pacheco carried out the decoration of sculptures, turning the polychromy of sculptures into a speciality within their painting workshops [Rios 1998, 7].

A systematic survey of the condition of the polychrome sculpture collection belonging to the Évora Museum was envisioned as part of a research fellowship in conservation, which is taking place at this museum, under the coordination of José de Figueiredo and the HERCULES Laboratories. The collection of polychrome sculpture in the museum is based around the personal collection of Frei Manuel do Cenáculo and comprises art, confiscated after the dissolution of religious orders in the mid-nineteenth century. A part of the collection is from a church that was integrated into the museum in 1917. This church, Nossa Senhora das Mercês has richly decorated gilded wood that dates from 1760 and is attributed to a local carver, Jorge Guerreiro [Espanca 1966, 133]. However, neither the contract for the altarpieces, nor any other documentation, contains reference to the integral sculptures.

From the dozen of baroque wooden sculptures inventoried as belonging to this church, there are some examples that show similarities on a decorative level, with regard to the composition and shape of the punch work used in the estofados. This painting and incision technique was used to simulate rich silk fabrics in the garments of the sculptures. This paper reports on the case study of two late seventeenth or early eighteenth-century sculptures, Santa Rita de Cássia and Santa Cecilia, that belong to this group (Figure 1 and 2).

Through the material-technical characterisation of these sculptures, which has confirmed decorative similarities, this study aims to present new data that may lead to a possible attribution to the same workshop or the same partnership between the sculptor and the painter-gilder. Nonetheless, the broader objective is to contribute to a better understanding of this category of regional art. This study will focus on the stratigraphy of the estofado decoration.

**Formal Analysis. Estofado technique**

The estofado technique is thought to have its roots in Flanders, or in Italian wood painting from the fourteenth century [Ríos 1998, 55]. The technique imitates rich silk garments with metal threads, by scratching into a paint layer to reveal the gold layer below. After the gilding, the gold leaf was covered by a polychrome layer, designs were drawn, and the paint was scraped away to reveal the underlying gold layer. The large visible areas of burnished gold were tooled to imitate the contrasts of light provided by silk and metal threads. The estofado techniques on the sculptures of our study correspond to this description.
The monochromatic garment and mantle of Santa Rita reflects a traditional iconography in the simplicity of the nun's habits, reduced to black, with parts of white on the hood and inside the sleeves. By comparison, Santa Cecilia's garments have a wider palette consisting of red, green, blue and white.

Esgrafito and punch work

The garments of Santa Rita exhibit always the same pattern, complemented by a range of winding, vegetal elements that end in a stylized flower of four petals. The garments of Santa Cecilia are composed of a bodice, a skirt and a garment which covers the feet, and a mantle. The bodice and the garment both have the same floral patterned motifs in red and white. The bodice has a range of winding vegetal elements, and two birds as central theme, on a green ground. The red mantle has a central element, complemented with vegetal elements.

If at first glance there does not appear to be obvious similarities between the two sculptures. Using magnification tools, however, the similarities become more obvious. In each mantle, the main motif of the estofado (for St. Rita a flower and for St. Cecilia an artichoke) is placed on the central axis and designed symmetrically. The secondary motifs, that fill the spaces between the principal elements, are also repeated symmetrically in relation to the central axis. Some of those secondary elements are very similar in both sculptures, which may suggest the use of models. However, it is the incised decoration that reveals the similarities between them, because the shape of the punch work is exactly the same. In both cases, a propeller-like shape of 1.3 mm has been
used. Furthermore, the location of the punched areas is precisely the same, and forms have the same compositions (Figure 3 and 4).

**Experimental**

Samples were collected and mounted in epoxy resin. The stratigraphic observation was performed using a stereo-zoom Leica M205C microscope, with a Leica DFC290HD camera for image acquisition. The characterisation of different materials in the preparation layers, bole, gold leaf, and polychromy, were performed by Scanning Electron Microscopy, using a HITACHI S-3700N, with Energy Dispersive X-ray Spectrometry from a Bruker Xflash 5010 SDD spectrometer. The samples were also analysed by a confocal Micro Raman spectroscopy from Horiba XploRa 638 and 785 nm laser, spatial resolution 1µm, spectral resolution 5 cm⁻¹, maximum power 1 mW, CCD with 1026 x 256 pixels. The binders were analysed by Fourier Transform Infrared Spectrometry with a microscope Continuum of Thermo Nicolet with an IR spectrometer Nexus 670 FTIR.

![Figure 3. Left. Punch work on Santa Rita, garment. © Museum of Évora](image)

![Figure 4. Right. Punch work on Santa Cecília, garment. © Museum of Évora](image)

![Figure 5. Left. Preparation layer of Santa Rita by SEM-EDX. © Museum of Évora](image)

![Figure 6. Right. Preparation layer of Santa Cecília by SEM-EDX. © Museum of Évora](image)

**Results and discussion.**

**Preparatory layers**

In the garments of both sculptures, the ground layer has a white appearance. It was impossible to identify different strata within this white layer by OM which has around 400µm of width. The analysis made by SEM-EDX distinguished two different layers and indicated that the first layer, closer to the support, has the larger particles (Figure 5 and 6). Both are composed of calcium,
associated with sulphur, suggesting calcium sulphate. The first layer also has dispersed iron oxides, and the second layer includes dolomite and very dispersed particles of Celestite (strontium sulphate). Due to the materials being of natural origin, these minor elements are indicative of gypsum, and the strontium inclusions may be helpful in locating the provenance of the materials [Goméz 2005, 48]. The difference of the minor elements suggests that the gypsum used in both layers were not simply variants of the same source. One is anhydried and the other hydrated. Unlike what is suggested in the treatises, these results show that, instead of preparing it himself, the artist used two types of calcium sulphate that had been already processed [Cardoso 2006, 79]. The question, however, is whether the dolomite inclusions are natural associates of the gypsum, or if they were added intentionally to provide some specific physical and mechanical properties.

The µ-FTIR and µ-Raman analyses demonstrated the presence of anhydrite calcium sulphate (CaSO₄) and gypsum (CaSO₄·2H₂O). The anhydrate layer is the first one above the wood, followed by the gypsum above. The data confirm once more that in Portugal, both in the south and the north, these two materials were widely used, and the recommendations of the historical documentation, such as the painting treatise of Filipe Nunes, were indeed followed in the production of the sculptures [Cardoso 2006, 75] [Barata et al. 2010, 22] [Serck-Dewaide et al. 2002, 131]. The apparently conscious utilisation of two different materials presumes two different goals. The first one was applied to homogenise the wooden support [Gómez 2005, 239]. The second one created, due to its morphology and in combination with the bole, an ideal surface for the burnishing of gold leaf and its subsequent tooled decorations [Gómez 2005, 241]. A micro-sample collected from a punch work area of Santa Rita’s garment, which was analysed by SEM-EDX, shows how the gypsum particles had been compressed. (Figure 7).

**Bole layers**

The bole layer is identical in both sculptures, with orange colour applied in all the extension of the garments, and with a maximum registered dimension of 40µm of width. Using OM, two applications were identified in the cross-sections. The first one comprises a very homogeneous orange layer, while the second one is more heterogeneous, mostly orange, but with some dark particles. SEM-EDX analysis indicated that this layer was composed mainly of iron (Fe), aluminium (Al), silicon (Si), and a very dispersed quantity of titanium dioxide (TiO₂). The dark particles were not easy to distinguish by SEM-EDX, and punctual analysis showed that they were...
composed of carbon (C). According to an anonymous recipe from the seventeenth century, the bole was mixed with gypsum and ‘lead pencil’ to obtain glossiness of the gilding [Ferreira-Alves 2002, 20]. Tejeda referred that plombagina (or graphite) is added to the bole, as its unctuous characteristics facilitate the process of burnishing [Tejeda 2001, 58]. Francisco Pacheco also explains that graphite, milled with water, makes the bole soft and satiny which facilitates the burnishing of the gold leaf [Bruquetas 2002, 429]. Even Filipe Nunes, in its seventeenth-century treatise advises the usage of two different boles, namely a common one first, and a refined one on top [Barata 2008, 14]. The black-grey particles were proven to be graphite, when analysed using µ-Raman spectroscopy (Figure 8). It is conclusive that, while the first layer remained unadulterated, graphite was intentionally added to the upper layer of bole.

Gold leaf

The gold leaf was applied over the layers of bole in both sculptures and was afterwards covered with a paint layer. The alloy identified, by SEM-EDX, proves the presence of gold (Au), silver (Ag) and copper (Cu). The semi-quantified analysis by EDX on different sites revealed an average composition of 95% gold, 4% silver and 1% copper. This indicates a very high purity of the gold leaf (about 22½ to 23 carats). The high purity and the total quantity of gold leaf used in the sculptures, even on the back, is an evidence of what was probably a very expensive commission.

Polychrome layer

As stated before, a paint layer was applied to all the gold leaf on the garments. The designs were made by removing the paint to reveal the burnished gold leaf below. A single layer of 16-30 µm in thickness was applied. All colours consist of a mixture of pigments and never of a single pigment, except for the white, which is composed of lead white in both sculptures. Santa Rita, as explained before, was decorated by using just two different colours, namely black, with some white details. The black layer contains compounds of calcium (Ca) and phosphorous (P), indicating the use of an animal-bone black pigment, mixed with iron oxides and calcium carbonate. The garments of Santa Cecilia have four different colours, that is red, white, green and blue. SEM-EDX detected a mixture of mercury (Hg) with lead (Pb) within the red paint. The presence of vermillion and minium respectively, were confirmed by Raman spectroscopy. The choice for using a combination of these two red pigments can be explained by the lower price of minium when compared to the price of vermillion, so minium is used as an extender [Barata et al.
2009, 206]. For the green and blue layers, copper (Cu) was identified as the main component, which was also present mixed with lead (Pb). The blue spectrum produced by Raman spectroscopy corresponds to azurite, but it was not possible to definitively identify the green colour by using the available databases for copper pigments.

Conclusion

This study revealed that the materials and techniques are, in general, in correspondence with the various recommendations and published studies about Portuguese polychrome sculpture of the same period. Results showed that both sculptures exhibit very similar characteristics in terms of the estofado techniques employed. The main similarities are the composition of the two different preparatory layers (anhydrite in the first and gypsum with dolomite in the second), the addition of graphite to the upper bole layer, the high purity of the gold leaf, and a single layer of polychromy with combined pigments to define the principal colour, except for the white.

The identified materials and techniques, in conjunction with the similarities observed in the decorative motifs and punch-work, support the hypothesis that both sculptures were made in the same workshop. Even without the names of the artists involved in the production of these sculptures, the objective of starting to group geographically dispersed polychrome sculptures has been achieved. Thus contributing to a greater understanding of this category of art.

Acknowledgments

The study was possible thanks to the research grant funded by Portuguese Science and Technology Foundation (SFRH/BI/51521/2011).

References


Please use the following when citing this paper:
The creative process revealed. The role of incisions, high-relief decoration and polychromy in the gothic altar frontal belonging to Sant Llorenç de Morunys.

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Abstract
The altar frontal from the church of Sant Llorenç de Morunys is a late thirteenth-century or early fourteenth-century polychrome wooden structure. At present, the altar frontal is in a precarious condition that neither allows the iconographical identification of its figures, nor its exhibition. However, a more in-depth study, together with contemporary bibliographical source cross-referencing, has permitted the authors to extract new information and draw conclusions. In order to obtain information about the evolution of the creative process, the study focuses on the marks made both in the ground layer for the realisation of the design, and on the high-relief decorations. Material components present in the traces left by a tool to implement the preliminary drawing have identified by X-ray Fluorescence Spectroscopy (XRF) and confirm the use of a dry technique using a lead-tin stylus. Polychrome techniques applied over tin leaf, such as glazing, were also studied. The iconography of the altar frontal has been revealed, and the identification of the final scene is now clear.

Keywords: Gothic painting technique, XRF, stylus, incised drawing, panel, translucent paint, medieval treatises.

Introduction
The antependium dedicated to Sant Llorenç is currently stored in the Museu Diocesà i Comarcal de Solsona (Catalonia, Spain) [1]. It was originally situated in the church of Sant Llorenç de Morunys, from which it was removed in 1918. It currently consists of a (damaged) gothic polychrome work applied to a wooden support. These layers are applied over an earlier scheme consisting of incised preparation layers. Its nine decorative compartments represent scenes from the life of Saint Llorenç, placed around the central archaic figure of the Majestas Domini into a mandorla and surrounded by Tetramorph emblems of the four Evangelists.

The frontal is greatly deteriorated due to the passing of time and the diverse modifications to which it has been subjected. At present, it does not meet the necessary conditions for exhibition because a comprehensive understanding of the ensemble is difficult for the viewer. This hinders, but does not impede the identification of the scenes represented. These can be identified thanks to the fact that the traces of the original incised underdrawing have remained intact (Figure 1).

Objectives
The goal of this study is to characterise and interpret the combination of strata and marks present on the gothic altar frontal. These now consist of the original ground layers and marks therein, which were executed either in freehand or using guides. Later applied gothic preparation layers have been identified beneath the remnants of the polychromy and gilding. These are sparsely preserved. Further, the study aimed to pinpoint the technology used to carry out this antependium, specifically the materials used to construct the original preparatory layers, the stucco reliefs, the gilding and polychrome decorative layers.
Methodology

The lack of continuity of the polychromy layers allowed the authors to carry out a detailed study of both phases of the now visible preparatory layers. Initial stages of the creative process and its evolution could be clearly observed. Observations were made by using the naked eye and magnifying instruments, assisted by different types of lighting.

Figure 1. Photo-montage of the antependium with the incised design layers superimposed (Adobe Photoshop). Frontal of Sant Llorenç de Morunys (MDCS 14). Thirteenth or fourteenth century. © Xavier Riu & Rosa Senserrich.

Subsequently, two micro-samples were removed from the polychrome areas, mounted as cross-sections and analysed by Arte-Lab [2]. Analysis was implemented using an optical microscope, and by undertaking selective staining and micro-chemical tests. To confirm the identification of materials the following analytical techniques were employed: Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM-EDX), Fourier Transform Infrared Spectroscopy (FTIR) and Gas Chromatography-Mass Spectroscopy (CGMS). The interpretation of the analytical results has allowed the authors to ascertain the distribution of some of the materials, such as the stratigraphic position of the metallic leaf and the varnish. Furthermore, the composition of other materials within specific layers could be identified, such as the ground layer and the type of metal employed.

Portable Energy-Dispersive X-ray Fluorescence (pXRF) measurements were carried out in-situ with a handheld Bruker Tracer IV-Geo analyser. The results allowed traces left by the tool used in marking the preliminary underdrawing to be mapped [3]. The results of the XRF analysis were compared to those with other results obtained within the laboratory. This provided complementary data, which confirmed the identification of inorganic pigment components present in the pictorial layer.

The scientific data obtained by analysing the materials could be compared with information provided in the bibliographical sources. Special attention was paid to the two core medieval art technique treatises by Theophilus and Cennini [Hawthorne and Smith, 1979] [Frezzato, 2003]. The twelfth-century text by Theophilus supplied technological information regarding the construction processes prior to the Sant Llorenç frontal, while Cennini’s well-known fourteenth-century treatise gives a clear overview of contemporary Florentine workshop practice.
Description of the frontal

A. Preparatory Layers

Preparatory ground layers of the pre-gothic period in southern Europe typically consist of a mixture of calcium sulphate combined with hide glue, which was applied in multiple coatings on a sized wooden panel. While similar to Cennini, Theophilus describes a variation in the materials used later, mentioning that the hide glue is cooked along with stag horn powder, and thereafter mixed with ground gypsum which is spread over the sized layer [Hawthorne and Smith, 1979, chap 18, 26-27].

The stratigraphic build-up used to create the decorative antependium could be clearly seen by studying lacunae in the superficial layers. Two distinct phases of preparation layers were identified.

![Figure 2. Left. The yellowish ground layer, visible in the centre, corresponds to an earlier layer. The remnants of a primitively incised drawing are also visible. The later gothic preparation layers are applied above. © Gonzalo Martí.](image)

![Figure 3. Right. pXRF spectra showing peaks for strontium, a contaminant material in the gothic ground layer (inset). Curves with high lead and tin peaks correspond to the soft-point stylus. © Jordi Ibáñez](image)

(i) First ground layer. Earlier preparation

The first ground layer is a thin substrate with a smooth surface that has been carefully applied using fine-grained inorganic components bound in a fluid medium. This layer does not show the usual characteristics of painting practice from the later gothic period, and presumably must pre-date this period. There are no remains of polychromy, but instead, traces of a preparatory drawing can be distinguished. These remnants consist of red and black inks applied as washes and incised lines (Figure 2).

(ii) Second ground layer. Later gothic preparation

A second, later preparatory layer has been applied over the whole surface of the Sant Llorenç de Morunys altar frontal. This layer has a very light, ivory-white colour. It is quite thick (measuring more than 1 mm) and it consists of at least five thin gesso (calcium sulphate) strata, different textured, which cushion the existing overlying polychromy and gilding.

The selection of materials was less precise than in the previous era. The grain particle size of the lowest and middle strata is larger than that in the earlier preparation. Cennino refers to this application as *gesso grosso*. The particle size of the upper strata is finer. Again, this complies with Cennino’s technique in which *gesso sottile* is applied to create a smooth surface on which to paint [4].

The adhesion between the last strata of the upper preparation layer is not good. Flaking occurs in some areas and in other places these layers are friable, probably caused by the different physical response to the stress between the poorly refined, low-quality calcium sulphate used as *gesso grosso* and the more refined used as *gesso sottile*. (Figure 3, inset).
Correlation with analytical results

The results obtained via analysis support the initial conclusions made by the authors. Two pXRF-spectra from the second gothic preparation layer are shown in Figure 3. These spectra were obtained from areas with (red in Figure 3) and without (black in Figure 3) any visible preparation drawing. Peaks associated with calcium (Ca) and sulphur (S) were identified in all spectra. These elements dominate the low-energy spectral region and relate to calcium sulphate (CaSO$_4$).

Additional peaks were associated with the following elements: iron (Fe), lead (Pb), and strontium (Sr). These elements are detected above 5 keV. The presence of these elements needs some further illumination. Iron is a common impurity found in gypsum, thus its presence can be easily explained. However the presence of lead was puzzling. This element may have been present in overpaints dating probably from the baroque period and partially removed in 1920, as described in the documentation kept in the museum.

Strontium, present in the compound celestine (SrSO$_4$), is also typically found as an impurity of calcium compounds [Deer et al. 1992]. Large amounts of this element were detected within the second, later, gothic ground layers. Additional pXRF-spectra were taken of the earlier ground layers and a comparative overlay of the results can be seen in Figure 3. The spectra obtained from the earlier ground layer is shown in blue. Comparing the two spectra led to the conclusion that there is a greater quantity of strontium in the later gothic ground layer than in the earlier preparation.

The interpretation of the elemental mapping of cross-sections using SEM-EDX allowed the authors to pinpoint where strontium is present within the various strata. No sizable amounts of strontium were detected in the uppermost layers of the later gothic preparation. Thus, considering the penetration depth of the energy recorded in the pXRF measurements, it can be assumed that the celestine compound is associated with the gypsum present in the lower *gesso grasso* layer of the later gothic preparation application. The SEM-EDX analysis confirmed this.

Figure 4. Detail showing an image of an area of missing stucco reliefs in the later gothic preparation. 1) **outlines**: a vertical mark left by a hard metalpoint instrument of a light grey colour; 2) **sketch**: dark grey marks left by a lead-tin stylus; 3) **incised drawing**: deep incision made by a hard metalpoint instrument. © Gonzalo Martí.

B. Application of the drawing

Once all the gesso layers had been applied and dried, a general outline drawing was executed in freehand or using suitable tools such as rulers, compasses or snapped cords [Hawthorne and Smith 1979, chap. 22, 29].
The definitive drawing over these outlines were usually executed by using dry techniques (styli and metalpoints) or water-based techniques (brushes) [5]. Direct incisions completed the lines and were indistinctively used in both procedures and phases of the drawing.

Each stage of drawing implied two phases, which were carried out almost simultaneously. First, a provisional sketch was outlined to set up the volumes and forms, and later, the definitive drawing enhanced some of the lines sketched before. In both cases, drawing could be done freehanded or by using different tools.

In the frontal of Sant Llorenç, the two preparation layers, dating from different periods, have both traces of a drawing with these two phases. The drawing applied to the later gothic preparation layer is clearer and more easily distinguishable. The primitive drawing on the earlier preparation is only visible in the few losses in the upper later preparation layers. There are thus few marks that can be directly associated with this design. The later gothic drawing is more complete, as described below.

(i) First stage. The general outline

The basic compositional elements of the Sant Llorenç de Morunys altar frontal were outlined on the later gothic preparation layer with lines made with a hard metalpoint stylus. Traces of metal were detected in these lines. These appear as a light grey line, in which the colour is hardly perceptible. Depending of the pressure exerted by the stylus on the gesso layer, the lines become faint incisions. These lines are often straight, indicating the use of a ruler.

(ii) Second stage. Preparatory drawing

Traces of the tools used to execute the definitive (upper) design are visible in the lacunae where the relief decoration is missing. An overview of the various tools, the marks created and the traces left behind is given in Table 1 and shown in Figure 4. The completed decorative pattern was applied using the initial outline as a guide. The artisan delineated the architectural setting and elaborated the figurative motifs within these sections beginning with a freehand sketch, using a soft metalpoint stylus that left a shiny dark grey mark on the surface. Subsequently, this sketch has been enhanced with a hard metalpoint.

In this case, the design combines deeply marked incisions with fainter ones and dark grey marks. Traces of metal left by the soft stylus range in thickness from $\frac{1}{4}$ mm to $\frac{1}{2}$ mm. Elemental analysis of these remnants indicated the use of a lead-tin alloy [6]. The peaks corresponding to lead (Pb) and tin (Sn) (red curve in Figure 3) could relate to the use of this soft metalpoint instrument.

Many of the tentative grey marks from the sketch were incised at a later stage in the development of the drawing. Precise, deeper lines were used to guide the subsequent painting phase. The tool used to create these incisions must have consisted of a sharper, harder metalpoint. The line produced appears as deeply incised into the preparation layer [Frezzato 2003, 150]. Unfortunately pXRF measurements taken at these points did not detect any additional elemental information. The signal recorded could mask an overlapping peak of a weaker element present in the metal used to create these marks. This could be silver (Ag), which is the signal that is typically masked by the Bremsstrahlung radiation emitted by the X-ray tube.

The incised design on the frontal remains difficult to interpret in many areas, especially to the right of Majestas Domini. This area becomes clearer when studying the only drawing of the frontal published in 1929 by the priest and art historian Josep Gudiol i Cunill (1872-1931) [Gudiol i Cunill 1929, 313]. However, the last scene remained indistinct because this drawing did not give any information regarding the faint incisions presents in the work. Only after the accurate observation of the faint incisions during the current study, was the tomb of Saint Llorenç discerned [7].

The authors conclude that in many cases the incised lines were combined with metal leaf applications. In many areas these lines play an important role in the preparation of the application of relief patterns, as will be illustrated below.
**C. Application of relief decorations**

Little remains of the elaborate relief decoration delineating the dividing bands between the various compartments of the iconographical images within the altar frontal. Only a few are left (Figure 4).

The reliefs were executed using a warm paste generally made of calcium sulphate and animal skin glue, applied in a semi-liquid state with a brush. The incised lines in the preparation layer provided a groove, which would prevent the semi-liquid paste from extending onto the surrounding areas of the motif.

**D. Application of the polychromy**

Two distinct polychromy techniques coexist on the altar frontal. Much of the surface contains glazed tin leaf used to create a shimmering brilliant surface, imitating burnished gold. The tin leaf is applied to the preparation layers and decorative reliefs using an animal skin glue [Hawthorne and Smith 1979, chap. 24, 32]. The presence of collagen was identified by its distinct ultraviolet (UV) fluorescence observed under magnification. The presence of tin was confirmed by both SEM-EDX and pXRF analyses [8]. The backscatter electron microscope image (SEM-BSE) clearly shows the thickness of the tin layer. It measures approximately 35 micron (see Figure 5).

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**Table 1. Tools used to apply drawing to the lather gothic preparation layer in to the frontal of Sant Llorenç.**

<table>
<thead>
<tr>
<th>Tool</th>
<th>Material</th>
<th>Colour of the line</th>
<th>Usage</th>
<th>Stage of creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stylus</td>
<td>Hard metalpoint (pending identification)</td>
<td>Light grey/without colour</td>
<td>With a ruler</td>
<td>Outline</td>
</tr>
<tr>
<td>Stylus</td>
<td>Soft metalpoint (lead-tin alloy)</td>
<td>Shiny dark grey</td>
<td>Freehand</td>
<td>Preparatory drawing</td>
</tr>
<tr>
<td>Point / Needle</td>
<td>Hard metalpoint (pending identification)</td>
<td>Without colour</td>
<td>Freehand</td>
<td>Preparatory incised drawing</td>
</tr>
</tbody>
</table>

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**Figure 5. Left.** SEM-BSE image of a cross-section of micro-sample. Magnification: x250. (1) calcium sulphate gothic ground layer; (2) the material presenting the highest contrast (white) is the metallic tin leaf. © Arte-Lab, SL.

**Figure 6. Right.** pXRF spectra reveal the components of the inorganic pigments employed in the painter’s palette. Selected spectra from four different points on the altarpiece are shown: i) hat of Pope Sixtus II (red pigment), ii) sleeve of Sant Llorenç’s alb (white pigment), iii) wing of Sant Mateu’s angel (green pigment), and iv) wing of Sant Mateu’s angel (pale yellow pigment). © Jordi Ibáñez.
Opaque and translucent paints were used to create the iconographical image. These paints comprise typical pigments, dyestuff, binders and glazes of the period, which provide the colour to the figurative content of the work. Theophilus discusses in the first volume of his twelfth-century treatise the use of pigments and the technique of imitating shimmering brocade fabrics by applying thin glaze paints to tin leaf [Hawthorne and Smith 1979, chap. 27, 33-34]. Theophilus calls this technique ‘translucent painting’ and adds that other painters refer to it as *aurëola*.

In this phase, opaque paints were first applied to outline the contours and colour, both the figures and the cabochons found in the friezes. Glazes applied to the tin leaf followed. The pigments used are of good quality and fine-grained, corresponding to the type Theophilus recommends when describing how to paint on tin leaf.

---

**Correlation with analytical results**

Elemental analysis using pXRF determined the presence of lead (Pb), mercury (Hg), copper (Cu), and arsenic (As) as well as iron (Fe) and manganese (Mn) (Figure 6) [9]. Certain elements could be linked to specific tonal passages. This scientific data was corroborated by information provided in the contemporary treatises regarding pigment usage. Thus the authors could establish the use of the following pigments: lead white, red lead, vermilion, copper green and orpiment (Figure 7).

The pXRF measurements show that the red pigments contain elevated amounts of lead (Pb) and mercury (Hg). These results point towards a combination of two opaque pigments, namely red lead (minium) (PbO) and vermilion (HgS). Elevated amounts of lead (Pb) were found in white passages, thus suggesting that lead white (PbCO$_3$·Pb(OH)$_2$) was used. The spectra of the green paint passages exhibit strong response peaks for copper (Cu) and some lead (Pb), as well as a very weak signal for arsenic (As). It can be concluded that a green copper pigment and lead white were used. It was not possible to explain whether the arsenic signal originates from an element.
within this paint or from the surrounding material. Spectra obtained from the pale yellow areas are dominated by lead (Pb) peaks and also show a weak signal corresponding to arsenic (As). Interpretation of these results needs careful consideration as the main peaks for arsenic are superimposed over the strongest peak for lead. The weak arsenic signal in the pale yellow areas suggests that orpiment (As$_2$S$_3$) was mixed with lead white to obtain a pale yellow colour.

Binding media analysis of the opaque paints has not been carried out. However, it is likely that the technique used by the artisan follows the description of Theophilus. The monk explains that for painting on top of tin leaf the pigments should be ground using linseed oil instead of water [Hawthorne and Smith 1979, chap. 24, 25, 32].

pXRF-analysis of the still remaining glazes, which cover areas of tin leaf and adjacent black painted lines, did not provide a signal that could be associated with any mineral pigment. This suggests that both the yellow varnish and the delineating brushstrokes are coloured with organic compounds.

Using a semi-transparent, red paint applied onto the tin leaf, fine lines and motifs were painted with a delicacy of hand creating a highly colourful impression of great splendour and wealth. These nuances were created by combining warm and cold, matt and glittering areas. To create these effects much of the unpainted tin leaf surface would have been glazed with a tinted varnish. The amber hue would have been selected to imitate gold. This glaze also extended over some opaque paint areas to create a glossy effect. This seems to be a reminiscent of the translucent cold enamel method (Figure 8).

The exact composition of the varnish needs to be confirmed, but based on initial Gas Chromatography-Mass Spectroscopy (GC-MS) analyses, the authors can conclude that a terpenic resin mixed with a small amount of drying oil was used [10]. These results tally with the composition given by Theophilus of the varnish which he designates as gluten [Hawthorne and Smith 1979, chap. 21, 28-29], made with three parts fornis resin to two parts linseed oil [11]. The source does not mention, however, any type of coloration to be added to the gluten so it could act as a gold varnish over tin.

**Conclusions**

The existence of an earlier ground layer under the gothic one, completed with a drawing that used dry and water-based techniques, has led to a hypothesis that the altar frontal that was not completed and had remained unfinished without painting for some time. Probably in the late thirteenth or early fourteenth century, the wooden structure was subsequently painted with the rich polychromy that nowadays can hardly appreciated, due to its poor state of conservation.

A new and thick preparation layer was applied in the gothic period, covering the pre-existing one (or the remnants of the existing one). Another drawing was made using only dry techniques (freehand and incised lines). The extent and fineness of this incised preparatory drawing suggests that it had a specific function. It serves as a guide for the subsequent application of metal leaf used as a base to create glittering imitations of gold painted to emulate a variety of surfaces, fabrics and textures. If the intention was not to use metal leaf, then the extent of the incised lines would not be so capacious. It would not have been necessary to create such a detailed incised drawing using a hard metalpoint. Had that been the case, today there would have been no information regarding the narrative content of the work, preserved at least partly because of the existence of this incised preparatory layer. The incised lines would also aid in the process of putting the semi-fluid paste over the ground layer, delimiting the form of the reliefs.

This confirms the tightly-interwoven relationship established between the various techniques shown on the altar frontal, the materials used in the production of a work, and the meaning of the work itself. This relationship emphasises the fact that studying techniques, materials and meaning separately is often not feasible.
Acknowledgements

Gonzalo Martí Beltrán, for macro and detail photographs, and for the technical and logistic support provided. Josep Elvira at ICTJA-CSIC for his invaluable technical support. Jaume Bernades i Postils, Director of the Museum, for facilitating the analysis and study of the frontal. To the MNAC, specially Manuel Castiñeiras, Head of Romanesque Section, for his interest in this research work conducted by Rosa Senserrich-Espuñes during the 2009 UB-Masters Course.

Endnotes

1. The object is registered in the museum with the inventory number MDCS 14.
3. The measurements were performed with low (15 keV) and large voltages (40 keV) to optimise the detection of light and heavy elements, respectively.
4. pXRF analysis showed peaks associated with strontium (Sr). This element is present in celestine (strontium sulphate, SrSO$_4$). Celestine is an impurity associated with mined gypsum (calcium sulphate dihydrate, CaSO$_4$ · 2H$_2$O).
5. Cennini refers to styli of lead, tin, silver and bronze metal in his treatise. These could be used to draw on all sorts of different supports.
6. Cennini describes how to make a lead stylus by combining two parts lead to one part tin alloy, embossed with a small hammer [Frezzato 2003, 70].
7. Research carried out in 2009 by Rosa Senserrich-Espuñes.
8. The tin was identified by Arte-Lab, SL using SEM-EDX, and corroborated by the Institut de Ciències de la Terra Jaume Almera (CSIC) using pXRF. The collagen was identified also by Arte-Lab, SL using selective stains and optical microscope with UV light.
9. pXRF measurements of pigmented areas were carried out by the Institut de Ciències de la Terra Jaume Almera (CSIC).
10. Gas Chromatography-Mass Spectrometry (GC-MS) executed by Arte-Lab, SL.
11. Interpreting the text given in this chapter and the translators’ notes it can be gleaned that the fornix resin (glassa in Latin) could be a soft terpenic resin, such as mastic or elemi. Later, Theophilus compiles a second recipe in which the way this varnish is obtained by previously melting the resin with heat before adding oil to it, rather brings to mind a hard type of resin, such as copal, colophony or sandarac.

References


Please use the following when citing this paper:
The materials and making process of the relief painting technique of ‘applied-brocade’ in the Basque country.

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Abstract
The painted decoration of applied-brocade, more accurately described as applied tin-relief brocade, became a popular decorative technique in most of Europe, including Spain, from the middle of the fifteenth century to the middle of the sixteenth century. Instigated by the lack of thorough studies of the technique, in 2009 a PhD thesis regarding the analysis of the applied-brocades of Gipuzkoa was completed. This led to a broader research project that aims for a classification of the different types of decoration patterns and a description of the making procedures throughout the years of the applied-brocades on the altarpieces of the Basque country, northern Spain. Relevant documentary sources and laboratory work support this research. This paper presents the stylistic and material-technical study of a group of seven altarpieces. The similarities between certain decoration patterns show the close relationships among the workshops of a defined geographical area.

Keywords: Polychromy, late gothic, early renaissance, altarpieces, applied-brocade, filling, tin leaf.

Introduction
Stemming from the lack of in-depth studies in Spain, the first extensive research focused on applied-brocade has been carried out as a PhD study [Rodríguez 2011]. Applied-brocade was prevalent on wooden altarpieces, especially in northern Spain. Six early sixteenth-century altarpieces with extensive applied tin-relief brocade located in the Basque province of Gipuzkoa form the core works of this study. The project offers a complete analysis of the technique in the region. In order to broaden the geographical area where this painted decoration was used, the remaining altarpieces decorated with this technique within the Basque country are being studied, namely eight in Álava, nine in Biscay and one in the county of Treviño, enclave within Álava. The obtained results made it possible to compare the stylistic and material aspects of the applied-brocades of four regions (Gipuzkoa, Biscay, Álava and the county of Treviño).

The art historical context of the introduction of the applied-brocade in Spain and the Basque country
The decorative technique of applied-brocade is documented to have its origin in the period 1415-1430 in four different locations, namely Cologne, Berlin, Hamburg and Norwich [Nadolny 2000, vol. 1, 82, 324]. This assertion contradicts the old belief suggesting Flanders, a territory of the Low Countries, to be the point of origin [Gómez 2001, 576] [González 2000, 67]. Around 1450 it became a very popular decoration in artworks in most of Europe (Germany, The
Netherlands, Spain, Portugal, France, Switzerland, Austria, Lombardy, Bohemia, Sweden, England and Wales) [González 2000, 67] [Nadolny 2000, vol. 1, 78].

In particular, in the middle of the fifteenth century, numerous gothic triptychs, which were decorated with the technique, were imported from the old southern area of The Netherlands to Spain, due to the presence of the Basque ports. Around the first third of the sixteenth century, foreign artists arrived from northern Europe, who were familiar with applied-brocade and used it in Spanish late gothic artworks. At the same time, native painters began slowly assimilating and interpreting this type of decoration according to their own style and started introducing it in their own artworks. Burgos was the focal point of this technique in Spain. From there it appears to have spread to the rest of the Iberian peninsula [García and Ruiz de Arcaute 1998, 411, 413].

The popularity of applied-brocade declined in Spain and the rest of Europe from the middle of the sixteenth century on, giving it a range of use of approximately a century. Therefore, the technique can give an indication of when a work of art was manufactured. As the use of applied-brocade decreased, the *esgrafiado* technique became increasingly popular and finally triumphed towards the middle of the sixteenth century [Gómez 2001, 577]. *Esgrafiado* imitates rich fabrics by scraping delicate patterns into paint applied over a gilded surface, effectively replacing the appearance of an embroidered painting created by the applied-brocade technique.

**The making and application process of applied-brocade**

Applied-brocade is a three-dimensional decorative painting technique created by addition (applying material to the surface). Several recent publications provide thorough descriptions of the stages that the old artisans followed to obtain this decoration [González 2000, 70-73] [Rodríguez 2011, vol.1, 105-171] [Geelen and Steyaert 2011]. To summarise, the procedure consists of the following phases.

Firstly, the motif is engraved into a piece of hard wood, metal or stone which will become the mould. Then, tin leaf is placed on top of the mould and covered with flax fibres to absorb the beating of a mallet, which is used to press the tin leaf into the mould in order to duplicate the drawing of the engraved motif. To ensure the consistency of the tin, the latter is filled with a semi-liquid material that can be oil or protein-based substance, composed of different combinations of beeswax, resin, protein (like animal glue or egg white), oil (usually linseed), honey, fibres and a variety of particles. Once the filling material is almost dried, the tin leaf is separated from the mould and cut into either square or rectangular pieces to cover a large surface (juxtaposed applied-brocades) or free-shape motifs to decorate a surface in an arbitrary manner (isolated applied-brocades). The resulting brocades are usually adhered to the artwork with oil or protein-containing adhesives where proteins, oil, resin, wax are combined. Finally, in most cases, the applied-brocades are gilded with gold leaf, using a mordant, or painted with opaque paints and glazes to embellish the motif of the brocade.

The layered structure that results from this practice and that is characteristic of applied-brocade consists of eight layers. From bottom to top: 1) ground 2) *imprimatura* 3) adhesive 4) filling mass 5) tin leaf 6) mordant 7) gold leaf 8) opaque paint and/or glaze [Rodríguez and Bazeta Gobantes 2008, 5].

**Aims of the study**

The main goal of this paper is to provide an analysis-in-progress of the typologies, motifs, construction techniques and materials of seven altarpieces located in Gipuzkoa, Biscay and Álava. Two of these are in Gipuzkoa, namely the triptych of *San Antón* in the Church of San Pedro, Zumaia (circa 1510-1515) of an unknown workshop and the altarpiece of *La Piedad* in the Church of San Miguel, Oinate (circa 1533-1536) by Gaspar de Tordesillas, Andrés de Mendiguren, Miguel de Irargorri, Juan Martínez de Olazarán, Juan de Ayala II (carving) and Andrés de Espinosa (painting and polychromy) [Echeverría 2001, vol. 2, 478-484, 568-575].
can be found in Biscay, namely the main altarpiece in the Cathedral of Santa María de la Asunción, Lekeitio (circa 1507-1514) by Juan García de Crisal (painting and polychromy) amongst others and the main altarpiece of San Martín in the Church of San Martín Obispo, Arrieta (circa 1520-1525) by an unknown workshop [Echeverría 2001, vol. 2, 461-470, 515-519] [Muñiz 2011, CD 114-127, 188-193]. And three are in Álava, namely the altarpiece of El Santo Cristo in the Sanctuary of Nuestra Señora de la Encina, Artziniega (circa 1525-1550) attributed to the Beaugrant workshop, the main altarpiece of Nuestra Señora de la Encina in the Sanctuary of Nuestra Señora de la Encina, Artziniega (1510-1520) of an unknown workshop and the altarpiece of La Piedad or La Pasión in the church of Nuestra Señora de la Asunción, Delika (circa 1530-1550) attributed to the Beaugrant workshop [Barrio & Equipo 7 1999, 13-15, 41] [Bartolomé et al. 2009, 17, 45-49] [Echeverría 2001, vol. 2, 485-491] [Lucíañez 2009, 41-42]. Six altarpieces have been restored in the past two decades, excluding the altarpiece of Zumaia.

All of them show motifs of applied-brocade that can be found repeatedly on different altarpieces inside and outside the Basque country. Only one altarpiece presents two different motifs that are cut into two separate shapes. At present, these are the stylistic connections found between the applied-brocades of the altarpieces of the Basque country and other nearby areas. The study of the repeated motifs, their layering and mixtures assist in the understanding of the geographical dispersal of the technique through the years, the relationships among workshops and the attribution of non-documented altarpieces.

Methodology

Documentary sources, which are often non-published internal reports kept in official institutions and art conservation studios, are being studied in situ and analytical studies are being carried out [Barrio & Equipo 7 1999, 50-59, 69-75] [Lucíañez 2009, 25-34, 41-44, anexo II R1.a., R2.a.-R2.g., R4.a.-R4.c.] [Muñiz 2011, 103, CD 122, 191, 192] [Parra Crego 2004] [Rodríguez López 2011, vol. 2, 87-151, 168-254]. In particular, samples taken from different applied tin-relief brocades of each altarpiece have been examined using a range of analytical techniques. Optical Microscopy (reflected, transmitted, polarised and ultraviolet light), staining tests for proteins (Amido Black) and lipids (Rhodamine B), Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM-EDX) in low and high-vacuum mode, Raman Spectroscopy, Fourier Transform Infrared Spectroscopy (FTIR) with potassium bromide (KBr) plates, FTIR with an attenuated total reflection (ATR) objective (FTIR-ATR), Gas Chromatography-Mass Spectrometry (GC-MS) and High Performance Liquid Chromatography (HPLC) were applied. The use of multiple analytical techniques has been essential for the identification of both the organic and inorganic components.

The results. Typologies and motifs

The same juxtaposed motif can be seen on two different altarpieces of two provinces, namely in Artziniega and Briviesca, at 100 km distance of each other (Table 1, N.1 and N.2) and Zumaia and Arrieta, at 80 km distance of each other (Table 1, N.3). In just one case, the juxtaposed pattern is repeated in three altarpieces located in two provinces, namely Arrieta, Lekeitio and Zumaia (Table 1, N.4). Sometimes the same isolated motif is reproduced in two altarpieces located in two provinces, that is Zumaia and Lekeitio at 40 km distance of each other (Table 1, N.5), Oinate and Lekeitio at 60 km distance (Table1, N.6) and Oinate and Llanes at 250 km distance of each other (Table 1, N.7). The main altarpiece of Nuestra Señora de la Concepción in the church of Santa María, Llanes, is the first documented altarpiece with applied-brocade in the province of Asturias.

A common practice was to use a juxtaposed motif as isolated, either within two altarpieces located in the same province (Artziniega and Delika, Table 1, N.8) or within the same altarpiece (Artziniega, Table 1, N.9). Almost never an isolated motif was cut into a smaller one, as done on the altarpiece of Artziniega (Table 1, N.10).
The study of the types of applied-brocades on the altarpieces of Gipuzkoa, Álava, Biscay and the county of Treviño reveals that from the third decade of the sixteenth century on the use of applied-brocade decreased and mainly isolated motifs were reproduced.

**Materials and layering**

The brocades are glued once the preparatory layers are completed (Table 2). Firstly, the ground of calcium sulphate is applied in one or two layers made of a coarse yeso grueso of anhydrite on the bottom and a fine yeso fino on the top. A double-layer ground has only been found in Gipuzkoa. The binding media consists of a proteinaceous material, most likely animal glue, occasionally mixed with oil. A protein-containing sealing is not common and occurs in Gipuzkoa between the yeso grueso and the yeso fino and on top of the single or double layered ground.

Secondly, the imprimatura of the juxtaposed brocades is usually one layer of red iron oxide mixed with a protein. The isolated pieces show up to four layers, consisting of a combination of red iron oxide, silver leaf and a final coloured glaze of a proteinaceous material, which is sometimes mixed with oil.

Thirdly, beneath the brocade motif one stratum of an adhesive is detected. In juxtaposed applied-brocades the most common is an organic material (animal glue, oil or oil with resin) with no particles. A mixture of a protein and oil with calcium sulphate is only identified in several isolated brocades of Zumaia. The scarce application of an adhesive under this type of motifs can be explained by the use of sticky glazes in the imprimatura.

The applied-brocade itself consists of five layers (Table 3). The lower layer corresponds to the filling. Juxtaposed and isolated pieces are mostly filled with a lipid-containing material of beeswax, drying oil and resin in different combinations with addition of various pigments to speed up the drying of the relatively thick masses. No more than one layer is found in the fillings of isolated motifs. Whereas one, two and four layers are present in juxtaposed decorations. The multiple-layered fillings are typical of Gipuzkoa and Biscay.

Tin leaf (10-30 µm) on top of the filling is identified in both types of brocades. The adhesive is applied on isolated and juxtaposed motifs in one or two layers (three layers are observed in one isolated brocade of Zumaia). They consist of an oil-containing material frequently mixed with a protein. In general, particles have not been observed.

The adhesive adheres the gold leaf, detected in juxtaposed and isolated brocades, to the tin leaf. Silver leaf is reported in a juxtaposed brocade of the main altarpiece of Artziniega (Table 1, N.2) [Barrio and Equipo 1999, 52].

Juxtaposed patterns are frequently finished with more combinations of paints and glazes than isolated ones. White and blue paint (only blue for isolated examples) and red and green glazes (only red on isolated motifs) can be found. Paints contain a mixture of protein and oil, whilst glazes either oil or a protein. Two different colours within the same brocade piece have been seen in Álava, namely red glaze and blue paint in isolated brocades of Delika and red and white on juxtaposed brocades of the main altarpiece of Artziniega (Table 1, N.2, 8) [Luciañez 2009, anexo II R4.a.] [Barrio and Equipo 1999, 52]. At present no original protective layer has been identified.

**Discussion**

The repetition of several applied-brocade patterns in diverse altarpieces illustrate the spread of the technique among the workshops that practiced it. This information could be valuable for the attribution of non-documented altarpieces.

From approximately 1510 to 1525, repeated motifs, mainly juxtaposed, are found either along the Basque coast (Lekeitio, Arrieta and Zumaia) or in the interior regions (main altarpiece of Artziniega and Briviesca) (Table 1, N.1, 2, 3, 4, 5). From circa 1530 to 1550, only isolated patterns were reused in Álava (El Santo Cristo of Artziniega and Delika) or copied from previous artworks.
(Lekeitio, Llanes and Oinate) (Table 1, N.6, 7 and 8). These locations, except for Llanes in the northwestern coast of Spain, are spread along the commercial routes that connected the Basque ports with Burgos.

The variety and richness of the brocade patterns, the size and the execution date of each altarpiece, together with the fact that each workshop had its own individual set of motifs, indicate that very possibly Juan García de Crisal, maestro pintor, and his workshop (documented in the altarpiece of Lekeitio) first worked in Lekeitio (1511-1514), next or simultaneously in Zumaia (1510-1515) and afterwards in Arrieta (1520-1525) [Westhoff et al. 1996, 565-566]. This could explain the multiple repetitions of different brocade patterns in the three altarpieces.

The altarpiece of Oinate (1536), painted by Andrés de Espinosa, is connected to the main altarpiece of Lekeitio (1511-1514) and the main altarpiece of Llanes (1517), because they share the same pattern. Like the altarpieces of Lekeitio and Oinate, the altarpiece of Llanes is also attributed to a specific workshop, in this case the workshop of the painter and sculptor León Picardo, a north-European artist settled in northern Spain [Huidobro 1939, 191-193]. Sometimes, collaboration amongst master painters occurred, resulting in the exchange of brocade patterns. It is very probable that, before undertaking the polychromy of Oinate, Espinosa and his workshop collaborated in other altarpieces with the workshops of Crisal and Picardo. Thus having access to their set of applied-brocades’ planks among which were included the two above mentioned isolated patterns. Based on the construction dates and the common practice of reusing juxtaposed brocades as isolated ones, most likely the juxtaposed pattern used at the altarpiece of El Santo Cristo in Artziniega (1525-1550) was simplified into an isolated form in Delika (1530-1550). Both altarpieces are attributed to the workshop of the Beaugrant master.

The attribution of a motif to a specific workshop can be supported by similarities in making procedures and materials employed in the brocade. This can be demonstrated by several layers of the juxtaposed pattern reproduced in Lekeitio and Zumaia and by the filler material of the motif repeated in El Santo Cristo of Artziniega and Delika (Table 1, N.4, 8. Table 2 and 3). In this last case, the filling of Artziniega consists of gypsum and vermilion, whereas in Delika visual examination reveals a reddish white filling matching the colour and consistency of the filler at Artziniega (Table 3).

The altarpiece of Briviesca (1515) and the main altarpiece of Artziniega (1510-1520), that share two juxtaposed patterns, might probably have been polychromed at the same time by the same workshop. Unfortunately, the lack of attribution data does not allow further speculation.

Conclusion

The repeated patterns that have been studied should be carefully compared to confirm the suggested workshop interconnections. For that purpose, it is pertinent to take into account the following aspects. Every applied-brocade had its own mould that produced identical pieces and that belonged for several generations to the stock of moulds of a specific workshop. If collaboration occurred, patterns could be exchanged probably resulting in reproductions of moulds slightly different from their originals that were added to the stock of the workshop. Major differences in the brocade motifs could have been inspired by contemporary textile fabrics, graphic arts and paintings and could point to different workshops.

The extensive new corpus of stylistic connections provided in this paper has broaden the knowledge of workshop practice and the existing relationships in the geographical area of northern Spain, that comprises the provinces of the Basque country, Burgos and Asturias. In addition, many combinations of materials have been characterised and classified which leads to a better understanding of the applied-brocade. A large number of altarpieces still need to be examined in order to provide more stylistic and technical connections that will result in accurate attributions and in the dating of non-documented altarpieces.
Acknowledgements

The authors would like to thank Equipo 7 Restauración SA, art conservation studio and Jesús Muñiz Petralanda, Art Historian at the Diocesan Museum of Sacred Art of Biscay, Bilbao.

References


Rodríguez López, A. and Bazeta Gobantes, F. 2008. ‘Classification of the typologies, techniques and materials of the applied-brocades of the altarpieces of Gipuzkoa by means of the analytical techniques of laboratory’. The Open Access NDT Database 13 (9).


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### Table 1. Repeated motifs of applied-brocade found in different altarpieces, and similar motifs of applied-brocade, both juxtaposed and isolated, found in one or two different altarpieces. ©Ainhoa Rodríguez López

<table>
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<th>Motif</th>
<th>Brocade type</th>
<th>Altarpiece</th>
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<td>Chapel of Las Viejas, Briviesca (Burgos) (BU-R.9.A.)</td>
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<td>Lekeitio (Bizkaia) (LKT-2)</td>
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<td>Añieta (Bizkaia) (B1-R.1.B.)</td>
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<td>Lekeitio (Bizkaia) (LKT-E)</td>
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<td>(Asturias) (AS-R.1.A.)</td>
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<td>Delika (Álava) (R4.a.)</td>
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<td>represents the</td>
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<td>[Lucianez 2009,</td>
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Table 2. Mixtures found in the preparatory layers.

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<td>Juxtaposed and isolated</td>
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<td></td>
<td>Calcium sulphate, fibres (some strontium sulphate)</td>
<td>Protein</td>
<td>Isolated</td>
<td>Zumaia (II.7.A.)</td>
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</table>
|       | Gypsum (some earth pigments) | Not identified (protein, R2.a.) | Juxtaposed | Main altarpiece, Artziniega (R2.a., R2.d.)
|       | Gypsum, anhydrite, carbon black (some calcite and earth pigments) | Animal glue | Juxtaposed | Lekeitio (LKT-1, LKT-2) |
| Ground | Anhydrite? | Protein | Isolated | Zumaia (II.2.A.) |
|       | Calcium sulphate (bottom layer) | Protein (bottom and top layer) | Juxtaposed | Zumaia (II.3.A.) |
|       | Anhydrite (bottom layer) | Protein and oil (bottom layer); Protein (top layer) | Juxtaposed | Zumaia (II.8.A.) |
|       | Calcium sulphate (bottom layer, yeso grueso); calcium sulphate (top layer, yeso fino) | Protein | Juxtaposed and isolated | Zumaia (II.4.D., II.9.B.) |
|       | Anhydrite (some strontium sulphate) (bottom layer, yeso grueso); gypsum (top layer, yeso fino) | Protein and oil | Juxtaposed | Zumaia (II.9.B.) |
|       | Calcium sulphate (bottom layer, yeso grueso); calcium sulphate (intermediate layer, yeso fino) | Protein (yeso grueso, yeso fino and top layer) | Isolated | Oinate (III.9.G.) |
|       | Anhydrite, red iron oxide (bottom layer, yeso grueso); gypsum (top layer, yeso fino) | Protein (yeso grueso, intermediate layer and yeso fino) | Isolated | Oinate (III.14.C.) |
|       | Red iron oxide | Not identified | Juxtaposed | El Santo Cristo, Artziniega (R1.a.) |
|       | Red iron oxide | Animal glue | Juxtaposed | Lekeitio (LKT-1, LKT-2) |
|       | Red iron oxide | Protein and oil | Juxtaposed | Zumaia (II.8.B., II.9.B.) |
|       | Red iron oxide | Protein and resin | Juxtaposed | Main altarpiece, Artziniega (R2.b.) |
|       | Vermilion | Not identified | Isolated | Main altarpiece, Artziniega (R2.c.) |
| Imprimatura | Azurite (top layer) | Resin or gum (bottom layer); protein and oil (top layer) | Isolated | Zumaia (II.2.A.) |
|       | Lead white, carbon black, red iron oxide (some quartz, soda-lime glass) | Protein and oil | Juxtaposed | Zumaia (II.9.A.) |
|       | Earth pigments, calcium carbonate, lead white (some bone black) (bottom layer); gold leaf (top layer) | Not identified | Juxtaposed | Main altarpiece, Artziniega (R2.a.) |
|       | Red iron oxide (bottom layer); silver leaf (intermediate layer) | Protein (bottom and top layer) | Isolated | Oinate (III.15.E.) |
|       | Red iron oxide (bottom layer); silver leaf (intermediate layer); copper green (top layer) | Protein and oil (bottom layer); organic red and protein (top layer) | Isolated | Zumaia (II.3.B.) |
|       | Red iron oxide (bottom layer); silver leaf (intermediate layer); copper green (top layer) | Protein and oil (bottom layer, intermediate layer beneath the silver and top layer) | Isolated | Oinate (III.9.G., III.11.B., III.14.C.) |
|       | Red iron oxide (bottom layer); silver leaf (intermediate layer) | Protein and oil (bottom layer, intermediate layer beneath the silver and top layer) | Isolated | Oinate (III.9.G., III.11.B., III.14.C.) |
|       | None | Animal glue | Juxtaposed | El Santo Cristo, Artziniega (R1.a.) |
|       | None | Oil and resin | Juxtaposed | Lekeitio (LKT-2) |
|       | Carbon black | Hesin | Juxtaposed | Main altarpiece, Artziniega (H2.d.) |
|       | Calcium sulphate | Protein and oil | Isolated | Zumaia (II.2.A., II.4.D., II.7.A.) |
Table 3. Mixtures found in the applied brocade layers.

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<td>Protein</td>
<td>Isolated</td>
<td>Main altarpiece, Artziniega (I-II.B., II-2.B., II-2.C.)</td>
<td></td>
</tr>
<tr>
<td>Gypsum, vermilion</td>
<td>Not identified</td>
<td>Isolated</td>
<td>El Santo Cristo, Artziniega (R-1.a.)</td>
<td></td>
</tr>
<tr>
<td>Lead white, red iron oxide</td>
<td>Protein and oil</td>
<td>Isolated</td>
<td>Zumaia (II-2.A., II-4.D., II-7.A.)</td>
<td></td>
</tr>
<tr>
<td>Lead white, earth pigments, calcium carbonate</td>
<td>Beeswax and resin</td>
<td>Juxtaposed</td>
<td>Main altarpiece, Artziniega (R-2.a., R-2.d.)</td>
<td></td>
</tr>
<tr>
<td>Lead white, carbon black, red iron oxide (some quartz, soda-lime glass, organic red (bottom layer)); lead white, carbon black (some red iron oxide, quartz, soda-lime glass, azurite, red lead) (top layer)</td>
<td>Protein and oil (bottom layer); beeswax (top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-1.A., II-3.A., II-9.A.)</td>
<td></td>
</tr>
<tr>
<td>Lead white, carbon black, red iron oxide (some quartz, soda-lime glass, organic red (bottom layer)); lead white, carbon black (some red iron oxide, quartz, soda-lime glass, azurite, red lead) (top layer)</td>
<td>Protein and oil (bottom layer); beeswax (top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-1.B., II-8.A., II-9.A.)</td>
<td></td>
</tr>
<tr>
<td>Lead white, carbon black, red iron oxide, calcite (bottom layer); lead white, earth pigments, red lead (top layer)</td>
<td>Linseed oil (bottom layer); linseed oil, beeswax, resin (top layer); oil and resin (layer on top of the 2 particle-containing layers)</td>
<td>Juxtaposed</td>
<td>Lekeitio (LKT-1, LKT-2)</td>
<td></td>
</tr>
<tr>
<td>Mordan t</td>
<td>Oil</td>
<td>Isolated</td>
<td>Main altarpiece, Artziniega (R-2.c.)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Oil and resin</td>
<td>Juxtaposed</td>
<td>Leketio (LKT-1, LKT-2)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Protein and oil (bottom and top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-1.A., II-3.A.)</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>Oil (bottom layer); protein (top layer)</td>
<td>Isolated</td>
<td>Zumaia (II-3.B.)</td>
<td></td>
</tr>
<tr>
<td>Mordan t</td>
<td>Lead white, earth pigments, calcium carbonate (some bone black)</td>
<td>Not identified</td>
<td>Main altarpiece, Artziniega (R-2.c.)</td>
<td></td>
</tr>
<tr>
<td>Some lead white (top layer)</td>
<td>Protein and oil (bottom and top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-1.B., II-8.B.)</td>
<td></td>
</tr>
<tr>
<td>Some lead white, red iron oxide (top layer)</td>
<td>Protein and oil (bottom and top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-7.A.)</td>
<td></td>
</tr>
<tr>
<td>Lead white, red iron oxide (top layer)</td>
<td>Oil (bottom layer); protein and oil (top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-9.B.)</td>
<td></td>
</tr>
<tr>
<td>Lead white, red iron oxide (some quartz, carbon black, vermilion) (intermediate layer)</td>
<td>Protein and oil (bottom and intermediate layer) (top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-2.A.)</td>
<td></td>
</tr>
<tr>
<td>Gold</td>
<td>Gold leaf</td>
<td>None</td>
<td>Main altarpiece, Artziniega (R-2.c., R-2.d.)</td>
<td></td>
</tr>
<tr>
<td>Some copper green</td>
<td>Protein</td>
<td>Juxtaposed</td>
<td>Zumaia (II-9.B.)</td>
<td></td>
</tr>
<tr>
<td>Lead white</td>
<td>Protein and oil</td>
<td>Juxtaposed</td>
<td>Zumaia (II-8.B.)</td>
<td></td>
</tr>
<tr>
<td>Azurite</td>
<td>Protein and oil</td>
<td>Isolated</td>
<td>Zumaia (II-2.A.)</td>
<td></td>
</tr>
<tr>
<td>Azurite (some calcium carbonate)</td>
<td>Not identified</td>
<td>Juxtaposed</td>
<td>Main altarpiece, Artziniega (R-2.d.)</td>
<td></td>
</tr>
<tr>
<td>Azurite (some earth pigments, calcite)</td>
<td>Animal glue and linseed oil</td>
<td>Juxtaposed</td>
<td>Lekeitio (LKT-2)</td>
<td></td>
</tr>
<tr>
<td>Carbon black (some lead white, soda-lime glass) (bottom layer); azurite (top layer)</td>
<td>Protein and oil (bottom and top layer)</td>
<td>Juxtaposed</td>
<td>Zumaia (II-1.A., II-1.B.)</td>
<td></td>
</tr>
</tbody>
</table>

Applied-brocade in the altarpiece of the *Coronation of the Virgin of Errenteria, Basque Country.*

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Abstract  
The sculpted altarpiece of the *Coronation of the Virgin of Errenteria* originates from Brussels and was created in 1528. It has recently been attributed to the Borman workshop. It has a balanced and colourful polychromy, dominated by the brilliance of the gilding, the red tone of the lacquers and the blue of the azurite blue. The decorative techniques are profuse and refined. Among these, the continuous and local applied-brocade enriches the ensemble, providing texture and relief. The objective of this study is the characterization of this technique. The systematic examination of the patterns, both from morphological and technological points of view, the reconstruction of its models and the chemical analysis of its constituent layers have enabled the identification of a repertoire that allows comparison. Formal analogies have been established with patterns similar to the style of Master I*T, a frequent collaborator of the Bormans, together with other singular features that give the polychromer of the altarpiece of Errenteria a particular personality.

Keywords: Altarpiece, Brabantine altarpiece, sixteenth century, polychromy, applied-brocade, filler.

Working methods  
The study was divided into three parts:  
A. **Morphological analysis**, to determine the physical characteristics of the applied-brocades, namely types, sizes, measurements, reliefs, designs, striations and highlights.
1. The establishment of standard data sheets for the compilation of the information (Figure 1).
2. Location of applied-brocade motifs in the altarpiece.
3. The study of these motifs, with natural light, shallow angle (raking) light, digital and stereoscopic microscopy.
4. Photographs and macro-photographs, with natural, shallow angle (raking) and ultraviolet light. Digital microscope photography, 20x.
5. Exact copy (1:1) of the different patterns to obtain archaeological drawings, faithful to the original which are often incomplete.
6. Comparison and overlapping of different tracings corresponding to each pattern in order to complete the motif, with the result of reconstruction of patterns.

B. **Technological analysis**, to identify the materials that constitute the different layers (pigments, colorants, binders, adhesives, etc.), their stratigraphy and their function.
1. The study of the different layers with natural light with digital and stereoscopic microscopy.
2. Sampling of polychromy at significant sites to obtain cross-sections for the chemical analyses.
3. Chemical analyses of micro-samples. The techniques applied were Optical Microscopy (OM) with polarised, incident and transmitted light; halogen light and UV light, selective staining and micro-chemical tests; Fourier Transform Infrared Spectroscopy (transmission-FTIR and FTIR-ATR), Gas Chromatography-Mass Spectrometry (GC-MS), Scanning Electronic Microscopy-
Energy Dispersive X-ray Spectroscopy (SEM-EDXS). For the analysis of the dye from red glazes: High Performance Liquid Chromatography diode array detection (HPLC-DAD).

C. Comparative analysis to obtain conclusions about the authorship of the altarpiece polychromy.
1. Compilation of patterns of applied-brocade given in scientific publications.
2. Comparison of the results of morphological and technological analysis of the Coronation of the Virgin altarpiece with the compilation of the patterns from other sources.

Figure 1. Standard data sheets for the information compilation. © Albayalde

The altarpiece of the Coronation of the Virgin

The carved sculpted altarpiece of the Coronation of the Virgin of Errenteria, also known as the Altar de las Ánimas, originates from Brussels. As can be seen, written in the open book resting on the lap of the Virgin in the Pentecost relief, the polychromy was made in 1528. Its rectangular landscape format (169 cm × 296 cm) currently contains three major scenes, adorned at the top with gothic architectural decoration and along its base by a decorative panel of tracery (Figure 2).

The iconography is singular. The Coronation-Assumption of the Virgin is in the centre, represented by a kneeling Maria being crowned by the Holy Trinity symbolised by three human figures, namely God the Father, the Son and the Holy Spirit. To the right, the Last Supper, with the apostles grouped around a large table in perspective is depicted, and to the left Pentecost, with the moment of the descent of the Holy Spirit upon the Virgin. On either side of the central scene there is a vertical spacer panel, each of which contains smaller reliefs. Regrettably some of these
disappeared and others are incomplete. One scene represents the Burial of Thomas Becket and the others perhaps episodes from the life of Saint Gregory, and also maybe Saint Martin.

The altarpiece is housed in the Church of the Assumption, in Errenteria. It is a sixteenth-century building, although an earliest reference to a church on this site dates from 1384 [Vázquez Escudero and Muro Arriet 1993].

![Image of the altarpiece](image.png)

**Figure 2. The altarpiece of the Coronation of the Virgin of Errenteria, overview. © Albayalde**

**Origin and attribution**

Documentation on the origin or the authors of the altarpiece has not been found. The first written reference dates from 1750 [Odriozola and Arizabalaga 2006]. In 1805 the historian Gamon hypothesised that the piece was brought to Errenteria from London by María de Lezo, a native of the town, and lady-in-waiting to Catherine of Aragon, the wife of Henry VIII [Gamon 1930, 312]. Weise establishes a link between the piece and other imported altarpieces of Flemish origin [Weise et al. 1927, 90]. This claim was later supported Arrazola, and more recently by Muñiz Petralanda [Arrazola Echeverría 1988, 18-20] [Muñiz Petralanda 2001, 133].

At present it is not clear whether the altarpiece was a commission, or whether it was purchased in the flourishing markets of the Netherlands or even Castile. The location of the town of Errenteria, at the end of the canal from the port of Pasaia on the bay of the Biscay coast, provided considerable mercantile and fisheries activity in the fifteenth and sixteenth centuries [Irijoa Cortés, and Martín Sánchez 2012].

The recent restoration verified that the altarpiece is not marked, as would have been required by the regulations of the guilds to guarantee quality and provenance [1]. However, dimensions based on the Brussels's foot, the results of the dendrochronological measurements and the general analysis, together with the fact that it belonged to the circle of Brussels, agrees with the date that appears in the book of the Virgin [Barrio Olano and Berasain Salvarredi 2013]. Perier-D'Ieteren places the altarpiece of Errenteria among those made between 1510 and 1528 by the Borman workshop, a prestigious family dynasty that specialised in the manufacture of altarpieces [Perier-D'Ieteren 2013]. D'Ieteren also recognises the intervention of two different hands in the sculpture, with clear similarities to pieces attributed to Jan III and Passier Borman. She also establishes different origins between these scenes and other groups of sculptures, such as the Burial of Thomas Becket, which clearly originated in Antwerp.
General features of the polychromy

The altarpiece shows a balanced and colourful polychromy, dominated by the brilliance of the burnished gold, the bright red lacquers and the azurite blue as its main tones. This chromatic harmony is supported by the lesser extents of the whites of the faces, veils and cloths, which accentuate the contrast. The incarnations are delicate, subtle, sober and idealised, with individual peculiarities.

The polychrome decorative techniques contribute effects of texture and colour. *Sgraffito* is the most used technique, being present across the three major reliefs of the altarpiece. It creates geometric, floral or written text motifs of different degrees of complexity. Continuous and local applied-brocade sheets cover the clothes and the altar tables. The punchwork provides nuances to the brilliance of the polished gold. Line gilding decorates the tunic of a single character and metal sheets of silver, gold or tin cover the architectural elements, mantles, stained glass, metallic elements and other objects.

The most laborious, complex and rich polychromy technique used in this altarpiece is applied-brocade. It reproduces, with great faithfulness and in series, the appearance of the brocades of the liturgical ornaments and of the garments of cloth embroidered with gold thread of the era [2]. In the altarpiece of Errenteria, the use of this technique is abundant, with both continuous and local applied-brocade sheets. Its distribution in the scenes is uneven. The *Last Supper*, being more elaborate in general, is the most decorated and is the only relief that shows local brocade. In the *Coronation*, however, only one character, the Virgin, wears a tunic of applied-brocade (Figure 3).
Morphological analysis

In the traditional practice, the selected design is engraved in a rigid mould, marking out the contours and carrying out the striation of certain areas. A sheet of tin foil is then pressed onto it to facilitate the modelling. A liquid mixture consisting of different materials is then applied. The result, when taken out of the mould, was a sheet with the design in relief.

![Figure 4. Continuous applied-brocade: fragments of plates and location on the sculpture in different directions. Left. Sculpture 1.1 Apostle, Pentecost; Middle. Sculpture 3.3.1 Apostle, Last Supper; Right. Sculpture 3.3.4, Last Supper. © Albayalde](image)

By contrast, in the continuous applied-brocade of Errenteria, the engraved plate has no design drawn on it and is simply a uniform relief made up of parallel striations. The drawing is made later in-situ, using a thin paintbrush, uniformly striated and gilded, once applied to the sculpture [3]. This is a similar technique to the one used on occasions for applied-brocades braid, which are absent in this altarpiece, being replaced by *sgraffito*. The plates are cut into several fragments and are placed on the sculpture in different directions (horizontal, vertical, oblique), which is an unusual way of application. As a result of this constant cutting, the actual size of the plates is difficult to establish (Figure 4).

![Figure 5. Continuous applied-brocade, Model nº 1. Left. In-situ; Middle. Relief Plate; Right. Reconstruction of design. © Albayalde](image)

The patterns of continuous applied-brocade in Errenteria are difficult to identify, as they are in a very poor state of conservation. Indeed, the observed design is, in reality, the tin left exposed by the loss of colour and the gilding. Despite this, it is possible to recognise two different patterns.
The first represents a small bunch of pointed leaves and small flowers, surrounded by a circular or oval structure (Figure 5). They are applied on the garments and have a maximum size of 6-7.5 cm, with 16-17 lines per cm. The second pattern, which decorates the altar tables of the small reliefs, is almost indistinguishable and its interpretation is questionable. The plate is bigger than the one in the previous pattern (8.9 cm × 11 cm) and the lines traced in relief are thicker (12-13 lines per cm). In both cases, on the gilding, the design was made in azurite blue and most frequently in the two red variants, mat and glaze. Several sculptures present continuous applied-brocades that have not been identified (Table 1). Judging by the number of lines per cm, they may belong to the first pattern.

Table 1. Continuous applied-brocades.

<table>
<thead>
<tr>
<th>Location</th>
<th>Model</th>
<th>Measurements</th>
<th>Relief</th>
<th>Striations</th>
<th>Striations / cm²</th>
<th>Highlighting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pentecost</td>
<td>1</td>
<td>H = 6 cm</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>16 - 18</td>
<td>Red Glaze</td>
</tr>
<tr>
<td>Apostle 1.1, Tunic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentecost</td>
<td>?</td>
<td>H = 7.5 cm</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>16 - 17</td>
<td>Red Matte</td>
</tr>
<tr>
<td>Apostle 1.3, Tunic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pentecost</td>
<td>1</td>
<td>H = 7.5 cm</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>16 - 17</td>
<td>Azurite</td>
</tr>
<tr>
<td>Apostle 1.5, Tunic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronation</td>
<td>?</td>
<td>7.7 cm</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>16 - 17</td>
<td>Red Glaze</td>
</tr>
<tr>
<td>Virgin 2.4, Tunic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last Supper</td>
<td>?</td>
<td>?</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>16 - 18</td>
<td>Azurite</td>
</tr>
<tr>
<td>Apostle 3.3.1, Tunic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Last Supper</td>
<td>1</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>17 - 18</td>
<td>Red Glaze</td>
<td></td>
</tr>
<tr>
<td>Christ 3.3.4, Tunic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 8</td>
<td>?</td>
<td>6 x 7.5 cm</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>12 - 13</td>
<td>Red Matte</td>
</tr>
<tr>
<td>Altar Table</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group 9</td>
<td>2</td>
<td>8.9 x 11 cm</td>
<td>Parallel Striations</td>
<td>Vertical</td>
<td>12 - 13</td>
<td>Red Matte</td>
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<tr>
<td>Altar Table</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 6. Local applied-brocade. Reconstruction of the relief: (left to right) models nº 1-2-3. © Albayalde

With regard to the local applied-brocades, three different patterns have been identified, all of them inspired by plant motifs (Figure 6):

Pattern 1: Three branches with stylised and pointed leaves and the occasional flower emerge from a small basket. The three pieces are independent, the middle one being lower, and the one at the bottom has a round form. The two sides join in such a way that the form of the opening can change, depending on the space available to adhere them, thereby changing the dimensions of the motif (2.1 × 5 cm, 2.5 × 4.6 cm, 4.2 × 4 cm).

Pattern 2: Seven rounded leaves on a small stalk, the upper one being hollowed out in the centre (5 × 5 cm approximately).
Pattern 3: A large leaf that emerges horizontally on both sides of a central pomegranate with crisscrossed lines and a perforated top (5.5 \times 5 \text{ cm}).

Other smaller fragments of brocade decorate the lacquered surfaces, but it is difficult to identify them. They may be remains of the motifs described previously or of other non-recorded motifs. Their manufacture is different from that of the continuous brocades and follows the traditional practice. In the three patterns, the relief marks follow the contours and the main lines of the design of the motif (veins of the leafs, crisscrossed lines of the pomegranate) with vertical striations.

**Technological analysis**

The patterns of continuous applied-brocade show a rather uncommon technology. The filler consists of two layers. The first, whitish and in direct contact with the tin foil, is wax-based (20-25 \text{ µm}). It basically fills in the areas of relief. The second is orange (25-150 \text{ µm}) and consists of white lead, minium, earth and sometimes calcium carbonate, yellow earth and even azurite in small quantities, mixed in oil. The brocade sheet created in this way is applied to the selected area of the sculpture, which is covered with the traditional preparation based on calcium carbonate. This ground is also covered with another layer, also of an intense orange colour and with similar characteristics to the second filler, although not so thick (15-20 \text{ µm}) (Figure 8) [4].

![Figure 8. Left. Cross-section of a continuous applied-brocade. Image obtained by transmitted light microscopy (MPlan 50X objective / 0.75). Right. Image obtained by Scanning Electron Microscopy SEM (BSE 800 X objective). Layers: 8) Gold leaf with thin mordant. 7) Grey degraded tin foil. 6) Filler 1: beeswax. 5) Filler 2: orange opaque layer: lead white, red lead, azurite, calcium carbonate and linseed oil. 4) Adhesive: orange opaque layer: lead white, red lead, earths, calcium carbonate and flax oil. 3) White opaque layer: lead white, red lead, calcium carbonate and linseed oil. 2) Red bole. 1) White chalk ground. © Arte-lab](image)

This complex structure poses a number of questions. The purpose of using a second filler is unknown. It seems to exist to strengthen the brocade sheet that ensures the stability of the wax relief, which is very fine and easily deformable. It is not clear why a stratum similar to the second filler has been applied on the preparation of the sculpture. Possibly it acts as an adhesive. The composition of the other layer is traditional, namely tin foil (50-80 \text{ µm}), a linseed oil-based mordant and a sheet of gold leaf (0.3-1 \text{ µm}). The gold leaf is of good quality, with a variable amount of silver in the alloy (1.4-2.6\%). In one of the analysed samples the gold leaf contains a small percentage of copper (0.5\%). The morphology of the local applied-brocades is more common. They are all located on garments decorated with red lacquered silver plate, this being identified as a mixture of colouring agents derived from madder lake and kermes [5]. The three patterns are cut and placed on the lacquer, probably when the stratum of colour was still mordant, as no adhesives are observed. The filler consists of wax, without any extra coats, although its thickness is greater than in continuous brocades. In one of the samples the wax is mixed with white lead, minium, earth, calcium carbonate and oil (100 \text{ µm}).
Comparative analysis

The mentioned Pattern 1 of continuous applied-brocade, although not identical, has clear formal similarities with the pattern repeated in the works polychromed by Master I*T, consisting of a bouquet of flowers and lanceolate leaves in a basquet inside an ogival framework [Geelen and Steyaert 2011]. It is present in the altarpiece of Saluces, the Holy kinship altarpiece, Gustrow or Vadstena, attributed to this master. In this model, the design is engraved in the mould and combines striations with flat areas and contours in relief. Consequently, the elaboration method is dissimilar from the fully striated plate of Errenteria.

The recent study by Geelen and Steyaert show that there can be several manufacturing techniques of the brocade, although exceptions to the standard techniques are not very common [Geelen and Steyaert 2011]. Indeed, the only documented example of striated vertical continuous parallel work is on the altarpiece of Gaasbeek (1520-1525), which does not seem to have other specific similarities to that of Errenteria.

In any case, this style of work, except for the engraved drawing in the mould (whose only relief consists of parallel grooves), could be interpreted as a simplification of the traditional technique. This simplification is also observed in the brocade of the curtains of the altarpiece of Saluces, which are uniformly striated and with punched lozenges, or in the mantle of Christ in the Altarpiece of the Passion in the Mayer van der Bergh Museum, which shows continuous striation and dotting. The brocade of the tunic of the Virgin of the altarpiece of Strängnäs III (1507-1508) is comparable. Here the pattern is obtained by stamping a thick fabric onto the tin foil and painting freehand on the gilding [Geelen and Steyaert 2011]. Given the late date, this could indicate a search for a simpler technique in the final years of manufacture. The existence of such elaborate and technically orthodox examples, such as the altarpiece of Vadstena, Västerås III and Gustrow seems to refute this hypothesis. However, the two situations are contemporary and perhaps not necessarily contradictory.

![Figure 8. Local applied-brocade. Individual patterns are indicated in boxes. © Albayalde](image)

The continuous applied-brocade of the altarpiece of Skepptuna, polychromed by Cornelis I van Coninxloo, which represents a stylised pomegranate, offers some resemblance to this model. However, comparison is difficult because it is partially lost.

The motifs of the local applied-brocade of Errenteria do not repeat models identified until today in other altarpieces, neither are similar to recurrent patterns in polychrome works by Master I*T.
In addition, the location in the same area of different local applied-brocades seems to be an unusual practice (Figure 8).

Regarding the technology, the double layer of filler and the thick adhesive covering the sculpture is not very common. The brocade of the clothing of the angel that holds the viola in the *Holy kinship altarpiece* in Auderghem (1490-1500) contains two intermediate layers between the filler of brocade and the coloured surface of the tunic [Sanyova 2002, 87]. In the set of brocades applied to the Brabantine altarpieces both cases are exceptions to the rule.

**Conclusion**

In general terms, the polychromy of the altarpiece of Errenteria follows the traditional characteristics of the Brabantine workshops. It shows clear similarities with Brussels altarpieces made by the Borman workshop around 1500-1525, as Gustrow, Saluzzo, Villberga or Västerås altarpieces among others, recently attributed to the Master I*T.

However, the repertoire of models of applied-brocade of the Errenteria altarpiece is peculiar and does not correspond to the patterns identified in these mentioned other altarpieces. Despite some formal similarities, the fully striated plate, the mode of application and the different constituent layers of the continuous applied-brocades differ considerably. Concerning the local applied-brocades, we have seen that neither the models, nor their combination in the clothing are common.

All these peculiarities, and the fact that in Errenteria there is no braid brocade as is usually in works produced by Master I*T, makes it reasonable to consider the presence of a different polychromer. The absence of documentation on the origin, authorship or purchase of the altarpiece, in addition to the lack of wood marks or specific signatures [6], makes it impossible to identify the author at present.

**Acknowledgements**

The authors would like to thank the researchers P. Fraiture, J.A. Glatigny, C. Perier d'Ieteren, J. Sanyova, M. Serc-Dewaide; the conservators V. Aldabe, L. Artetxe, S. Sarasua, P. de la Serna and the design's collaborators I. Colado, R. Fernández, I. Salaberria and I. Mantirian.

**Endnotes**

1. The altarpiece has undergone major modifications throughout its history. The loss of the painted and sculpted wings, of the *predella*, and the inversion of the lateral scenes and the sawing of the side frames are examples.
2. The technique has been well described by several authors.
3. The poor state of general conservation of the brocades prevents us from making systematic observations. In some case it is clear that the colour has been applied before the placing of the plate on the sculpture. However, the opposite procedure seems to be the most common.
4. In an analysis of applied-brocade in Errenteria an oil-based sealing layer has been detected on the chalk preparation [Rodríguez 2004]. This was identified by rhodamine staining. Rodríguez describes layers of primer on the preparation, which we interpret as the adhesive for the gluing of the brocade and the second filler. Another intermediate white layer has been found between the preparation and the adhesive of one of the samples analysed in the altarpiece of Errenteria, consisting of white lead, a very small quantity of minium, calcium carbonate, mixed in oil, 10 µm. Its function is not clear at present.
5. The colouring agent of the lacquers examined comes from the madder lake (*Rubia tinctorum* L.) and the kermes dyers (*Kermes vermilio* Planchon) of the dyers. Sanyova established a hypothesis that the lacquer of Errenteria was prepared using the fluff of the scarlet cloth, a waste material obtained after the shearing of the pieces [Sanyova 2013, 87].
6. In the border of the mantle of St Peter in the scene of Pentecost, there is a text that cannot be transcribed due to losses. It may be a kind of signature like the one on the altarpiece of the Virgin of Skeppta [Guillot de Suduiraut 2002, 277, 283].
References


Please use the following when citing this paper:

Decorative techniques. All ways to embellish and worship God.

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Abstract
The Roman Catholic church in Southern Europe has a rich decorative history. Artworks were used to embellish religious edifices, as devotional focuses, to educate the populace, and to disseminate religious instruction. Many techniques were used to embellish these sculptures and thus to worship God. Different materials to reproduce fabrics, garments, hair, jewels, three-dimensional decorations, glass eyes, fingernails, teeth, lashes, etc., were used in sculptures originating from at different places in Portugal. The interdisciplinary studies, such as physical and chemical examinations and studies in the history of art were important to understand the structure and composition of sculptures. This paper will present some of these interesting decoration techniques of baroque sculptures from different national museums and churches throughout Portugal, where they can still be seen and worshiped today.

Keywords: Sculpture, decorative techniques, Council of Trent, baroque epoch, material characterisation.

Sculptor and sculpting
Sculpture is the branch of the visual arts that operates in three dimensions. The object occupies a certain space with its volume. Sculpting is the creative activity of such action on objects. Created by shaping hard or plastic materials, the most common are stone, metal, wood, ivory, clay or wax. Different techniques are used to create art objects: directly by carving, assembled, built up and fired, welded, moulded, modelled or cast, just to name a few.

The sculptor can approach the material via two types of processes, either carving by removal of material (subtractive), or modelling by the addition of material (additive). Both techniques are applied according to mechanical properties, like malleability, ductility, hardness and resistance. Stone, metal, wood and ivory, can be carved or shaped with subtractive techniques. Added parts have to be nailed, screwed, using dowels or glued together. On the other hand, consistent materials, like clay and wax, can be modelled mainly with additive techniques, or by using iron tools and hot spatulas [Carvalho de Vilhena 2004, 18].

Wood is the most chosen and a very common material for the traditional process of carving a sculpture. It demands a good understanding of the nature of wood, such as its hardness and its grain structure. The type of wood, for example conifer, deciduous, or tropical, whether it is a hard or soft species, and how abrasive it is on the carving chisel, must be understood. A broad selection of mallets and chisels with different shapes and sweeps is required, and the carver must have some experience to know which tool to select for each particular situation in order to achieve the desired result. The traditional carver needs to have the skill to sharpen and hone the various chisels, which are shaped to suit individual carving styles and types of wood. It is apparent that a moderately proficient woodcarver needs a fair amount of technical knowledge and skill in order to produce a sculptural form. The length of time that it takes to acquire these skills will, of course, vary significantly from person to person [1].

In medieval cities, craftsmen tended to form associations based on their trades (guilds). Confraternities of textile workers, masons, carpenters, carvers, glass workers, wax workers, controlled secrets of traditionally imparted technology of their crafts. Usually the guild founders were free independent master craftsmen who hired apprentices and had strong bonds with the church, having patron saints that were regarded as guardians or protectors [Jovinelly and Netelkos 2006, 8]. The professional itinerary every artist had to do, was based on three fundamental stages: learning the skill as an apprentice (aprendiz), develop the skills as journeyman (oficial) and, after several years of experience, passing examinations to become master craftsman (mestre) [Ferreira Alves 1989, 69]. Surprisingly, these craftsmen or artists worked almost always
anonymously. They joined a chosen corporation or associated with the church, and worked without signing their work. Their objective was to please a higher entity, because they feared divine consequences, which was more important than their recognition as artists.

Nowadays only by linking formal and material characteristics, we can attribute an authorship to most of the Portuguese religious works of art. This is why the systematic study of this art is so important. It is a privileged moment when we can enjoy the work done by baroque wood carvers, sculpture and painter artists that, although working anonymously, delegated us magnificent works of art.

The importance of the Council of Trent

The Roman Catholic church in Southern Europe has a rich decorative history. Artworks were used to embellish religious edifices, as devotional focuses, to educate the populace, and disseminate religious instructions. The question with the presentation and role of sacred images was a very rigid one. Due to the need of spreading the catechetical message and the economic power it holds, the Roman Catholic Church has always been one of the best commissioners and consistent patrons of artists in almost every artistic field. Therefore, it is natural if the church wanted to give guidance and impose limits of decency to both objects and artists.

A council of the Roman Catholic church was held in Trento, Italy, between 1545 and 1563 to discuss the matters of decency and guidance. The council, for this period of eighteen years, examined and condemned, in three sessions, the teachings of Martin Luther and other protestant reformers, redefined the Roman catholic doctrine and abolished various ecclesiastical abuses while strengthening the power of the papacy. The most important session was the last one, the twenty-fifth session, held under Pope Pius IV in 1563. The discussion was mostly about the use of sacred images. The Pope wanted to reaffirm both the pedagogical and inspirational roles played by sacred art, as related in the Sacred council: “(...) And the bishops shall carefully teach this (...), the people is instructed, and confirmed in (the habit of) remembering, and continually revolving in mind the articles of faith; as also that great profit is derived from all sacred images, not only because the people are thereby admonished of the benefits and gifts bestowed upon them by Christ, but also because the miracles which God has performed by means of the saints, and their salutary examples, are set before the eyes of the faithful; that so they
may give God thanks for those things; may order their own lives and manners in imitation of the saints; and may be excited to adore and love God, and to cultivate piety” [2].

The image of Christ, of the Virgin (Mother of God), and of the other saints, should be kept and retained mostly in churches [Waterworth 1848, 234]. The sacred council also decrees to relics venerating (…) Moreover, in the invocation of saints, the veneration of relics, and the sacred use of images, every superstition shall be removed, all filthy lucre be abolished; finally, all lasciviousness be avoided; in such wise that figures shall not be painted or adorned with a beauty exciting to lust; nor the celebration of the saints, and the visitation of relics be by any perverted into revellings and drunkenness; as if festivals are celebrated to the honour of the saints by luxury and wantonness (…) [Waterworth 1848, 236-237].

Despite the large control over the use and decency of images representing the saints at worship, artistic production prevailed throughout the baroque epoch, and three-dimensional representations of religious images were customary.

![Figure 2. Left: Menino Jesus, Museu Nacional de Arte Antiga, Lisbon, eighteenth century, polychromed papier mâché, 50 cm height. © MNAA](image1)

![Figure 3. Right: Detail of human teeth, glass eyes and tear from Menino Jesus, Museu Nacional de Arte Antiga, Lisbon. © MNAA](image2)

**The list of sculptures observed**

Many techniques were used to embellish sculptures and thus to worship God. Different materials have been used to reproduce fabrics, garments, hair, jewels, three-dimensional decorations, eyes, fingernails, teeth, lashes in sculptures from different places in Portugal. Many sculptures with such decorations have been studied and conservation methodologies have been implemented over the last forty years in the sculpture department at the former Instituto de José de Figueiredo in Lisbon. The sculptures studied came mainly from convents and churches, where some are still being worshipped, and others from national Portuguese museums.

Among the most interesting cases of baroque religious art are roca statuary with movable limbs and textile dresses. Only the body parts that are visible, such as the head, hands and feet, are carved. This genre was created for a theatrical usage, being placed in a setting or on cars built for the occasion. This typology of sculptures could display various body positions in accordance with the pious scenic action represented during sacred mysteries or processions. This practice dates back to the Middle Ages when, in scenic representations of the lives of saints, the church borrowed from the marionette theatre the use of figures, dressed in accordance with the liturgical...
scene. In 1722 Rafael Bluteau [3] describes roca images like “(…) roca image and dresses, has the frame made out of sticks covered with dresses, which sustains it from the waist to the feet (…)” [Flexor 2005, 178].

The roca gender can be characterised distinctively:

1) Those with full anatomy but very simplified, dressed with fabric and garments
2) The anatomy partially represented, usually up to the waist
3) Those with whole body slatted or meshed except for the hands, feet and head
4) With articulated members [Flexor 2005, 166]

Some cases of devotional images of particular importance, have complete set of clothes and jewellery with some degree of luxury, to be worn at different festivities. In some cases we found out that parts of the hair, body or clothing of the sculptures had fabric, sisal fibres or wax inserted in the polychrome layers to fake hair, underwear, clothing or shoes. That was the case of a sculpture that represents a Virgin with Child (Virgem com o Menino, Nossa Senhora das Necessidades), belonging to the Capela das Necessidades in Lisbon (Figure 1)[4]. This roca sculpture with the anatomy partially represented, (only up to the waist) and with articulated upper limbs, was kept for a very long time in an uncontrolled environment, which damaged greatly the polychrome layers, the hair from both wigs of the Virgin and the Child and all their rich tissues and garments [Taxinha 1987, 20].

![Figure 4. Detail of drops of blood from Cristo crucificado, Museu dos Azulejos, Lisbon, seventeenth century, polychromed ivory, 86 cm height. © Museu dos Azulejos](image)

Another very popular three-dimensional decorations are tears, made of glass or natural resins, which add realism to the mourning sculptures. The tears were normally fixed on top of the final polychromy, with addition of glue or mastic in a very fragile method. That is the reason why most of the glass tears were either lost or broken, leaving empty incised mastic to be seen. The baroque Christ child (Menino Jesus), made of polychrome papier-mâché, and placed in an oratory that belonged to a convent (nowadays belongs to the Museu Nacional de Arte Antiga in Lisbon), is an example [Murta 2012, 67] (Figure 2) [5]. In addition, this sculpture also has inserted glass eyes and little teeth, probably human, glued inside the semi opened mouth to give a more naturalistic image of the young Christ (Figure 3).

In the baroque period the facial features were technically very elaborate. The physiognomy of polychrome sculptures was depicted by using the painted flesh tones, consisting of tempera with oil added binders. To be more trustworthy the oil painted surface could be polished with in water soaked thin lamb bladder. This is a technical procedure thoroughly explained by Filipe Nunes and often used in the baroque epoch [Nunes 1982, 106] [Ribeiro al 2002, 139]. Fine detailed brush dashes on the eyes, lashes and eyebrows gave a more authentic look to sculptures. In the case of the Crucified Christ representations, abundant drops of blood could be painted with red lacquer and resins, and three-dimensional faceted stones could be added to imitate drops of blood. That was the case of an oriental Crucified Christ (cigalo-portuguese) from the Museu dos Azulejos in Lisbon, made of a polychrome ivory support [Marcos 2009, 210] (Figure 4). Eyelashes, hair and beards of animal hair were added to masculine images. The sculpture representing a Crucified Christ (Senhor Jesus dos Lavradores) in the parish church of Santiago in central Portugal, Torres...
Novas (Ig. Paroquial de Santiago, Torres Novas), has little fibre tufts inserted in the wooden support to make the hair and beard of the figure (Figure 5) [6]. More common was the insertion of untangled rope covered with ground layers to represent the loose hair of young women such as in the case of one sculpture, Young Virgin (Imaculada), from the church Madre Deus in Lisbon [7]. The Immaculate is the New Eve and is a fundamental piece in the process of catholic redemption. The Tota pulchra amica mea was indeed one of the hymns that the novices had to learn first when entering a convent [Moura Sobral 2002, 31]. Due to a great amount of powder dust on top of the polychrome, one could not see the inscription Tota pulchra es Maria e demaco, written on the book held by the Virgin and that is why it was wrongly described as Saint Anne for years (Figure 6).

On a single known case by us, human nails were added to the fingertips of a Saint Anne, a baroque sculpture representing the education of the Virgin Mary (Figure 7). The sculpture can be found in the Museu Nacional de Arte Antiga in Lisbon and belonged once to a monastic order. It is a known fact that nuns did like to donate their hair or other natural materials, like their nails, to decorate images of their affection in a sort of natural way, or as payment of promises [8].

The most elaborate techniques were exclusive to the representation of polychrome garments. Among the most significant examples we could find were decorations in the ground layers, made prior to the elaborate polychrome layers. This technique can be executed in raised gesso, gilded and painted, or in wax set while hot, to obtain very fine details that are also gilded. This technique is called pastiglia decoration and can be found on a small size sculpture representing Our Lady (Nossa senhora da Oliveirinha) from the Museu Nacional de Arte Antiga in Lisbon [9]. On top of a greyish monochrome layer, an elaborate wax pattern of gold mixed with resin-oil as binder was applied in an elaborate three-dimensional decoration (Figure 8).

The Council of Trent stated very clearly that images or objects could not be exposed indecently or in a poor state of conservation. About this matter the sacred council decrees: (...) In fine, let so great care and diligence be used herein by bishops, as that there be nothing seen that is disorderly, or that is unbecomingly or confusedly arranged, nothing that is profane, nothing indecorous, seeing that holiness becometh the...
house of God (...) [Waterworth 1848, 236]. But holy images could not be destroyed or eliminated and for that reason they were frequently subjected to a deviation of the iconography and to changes in the formal aspect or the polychrome surface. For example, the Christ Child (Menino Jesus) from the church Madre de Deus in Lisbon was transformed to the iconography of Saint John (S. João) [10]. A Sedes Sapientia sculpture (Virgem em Magestade) from the church of Mercy, (Igreja da Misericordia, Proença-a-Velha), was significantly altered to a kneeling Virgin, with face and garments repainted and dressed up with uncharacteristic clothing [11].

Figure 7. Left. Santa Ana e Virgem Maria, Museum Nacional de Arte Antiga, eighteenth century, polychromed wood, 93 cm height. © Igreja da Madre Deus
Figure 8. Right. Detail of gilded three-dimensional polychrome decoration of Nosca Senbora da Oliverinha, Museu National de Arte Antiga, Lisboa, seventeenth century, polychromed wood, 0.30 cm height. © MNAA

Material characterisation

To understand past alterations and the iconography of sculptures, interdisciplinary studies were primordial. Physical exams, such as X-radiography, allowed to observe the interior structure of the sculptures, the insertion of glass eyes and the insertion of untangled rope as fake hair (Figure 6). X-Ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR) characterised the composition of the polychromy and the different pigments. Chemical examinations on cross-sections of polychrome samples, complimented the scientific studies. Alongside, art historical and iconographical research was done, to be able to assign an epoch of execution and fully understand the route of the sculptures since its creation.

The most unusual decoration were the inserted human nails on the sculpture’s finger tips. These were studied with the naked eye, but could only be identified as human material with Gas Chromatography (GC). By checking the results of the sample with a GC-analysis of a reference sample containing only human nail, the match was exact, confirming the presence of the natural organic material. With this paper we wanted to present some of the interesting decoration
techniques of baroque sculptures from different national museums and churches throughout Portugal, where they can still be seen and worshiped today.

Conclusion

In the baroque period in Europe, the catholic church was, along with the court, the biggest patron of art in this period. Art has a very own ability to capture different aspects of a message and to translate it into colours, shapes and sounds which nourish the intuition of those who look or listen. It does that without emptying the message itself of its transcendent value or its aura of mystery. The artists are the only intermediates of the message.

Large number of sculptures are in a poor state of conservation, due to its use and to the formal and polychrome changes over time, but also due to little maintenance and lacking preservation of spaces. Through the means of diagnosis and analysis it was possible to characterise much of the original materials and the fake intervention. By the knowledge and dissemination of the decorative aspects of religious imagery, we help safeguarding the knowledge of our art.

Endnotes

3. Raphael Bluteau was born in London, son of French parents, did his doctorate in theological sciences in Rome in 1661 and entered the Order of St. Caetano, who seven years later would call him to Portugal. In 1704 at the convent of Alcobaça, he reviewed his great work, the vocabulary of the Portuguese language in eight volumes (Vocabulario portuguez & latino, anatomico, architectonico ...), and many other works. In 1713, the Portuguese King John V ordered to print all his works [Bluteau 1712-1728].
4. Complete information can be found in the “Virgem com o Menino” restoration report EX-91, at the Laboratório José de Figueiredo Library and Archives.
5. Complete information can be found in the “Menino Jesus” restoration report 16-12, at the Laboratório José de Figueiredo Library and Archives.
6. Complete information can be found in the “Senhor Jesus dos Lavradores” restoration report AC-86, at the Laboratório José de Figueiredo Library and Archives.
7. Complete information can be found in the “Santa Ana” restoration report AS-98, at the Laboratório José de Figueiredo Library and Archives.
8. Complete information can be found in the “Santa Ana com a Virgem” restoration report CC-85, at the Laboratório José de Figueiredo Library and Archives.
9. Complete information can be found in the “Nossa Senhora com peanha em chiniseirê / Nossa Senhora da Oliveirainha” restoration report EB-94, at the Laboratório José de Figueiredo Library and Archives.
10. Complete information can be found in the “Menino Jesus/S. João Baptista” restoration report AA-96, at the Laboratório José de Figueiredo Library and Archives.
11. Complete information can be found in the “Virgem ajoelhada” restoration report 2-09, at the Laboratório José de Figueiredo Library and Archives.

References


Posters

(extended abstracts)
Study of the decoration of the polychrome wooden sculpture of *Our Lady* from the Church of Figueiró dos Vinhos, Leiria, Portugal.

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Originally the sculpture of *Our Lady* was an integral part of a larger Holy Family scene, but today the statue of Christ is missing and its location remains unknown (Figure 1). The figure of *Our Lady* shown in full-length and is made of solid wood. The support is constructed from several blocks which are attached to each other mainly by metal elements. The sculpture is 72.2 cm high, 35 cm wide and 22 cm deep and has a hexagonal base attached to the main block.

Figure 1. Left. Front View, Our Lady, from the Church of Figueiró dos Vinhos, Leiria. © Gonçalo Figueiredo

Figure 2. Right, Veil decorated with esgrafitado technique © Ana Rosa Carita

The sculpture is attributed to the workshop of Joaquim Machado de Castro (1731-1822). The carving is delicate. The style is typical of the baroque, as evidenced in the detailed swirling drapery, in the decorative foliage motifs and in the polychrome techniques utilised. The female figure is wearing a gown, a mantel and a veil. Each garment has a different decoration, both in terms of colour and decorative motifs. The whole sculpture is covered in gold leaf, except the flesh tones, hair and base. The decoration as a whole is of high quality, but unfortunately today part of the polychrome is lost or abraded, which impedes the identification of some decorative motifs. However, in some areas, where the polychrome colour is missing, the original decorative marks can still be seen in the gold leaf underneath.
Flesh tones

Different decorative techniques have been used on the face and the hands: the flesh tones of the face are shiny and polished, while the layers on the hands are matt; however, the hands have been repainted. Additional decorative elements have been added to embellish and provide more illusion of reality. The eyes are made of glass and have been placed inside the wooden block that forms the face. The hair is brown, although again this is not the original shade, since it has been repainted with a darker brown.

Veil

The veil is painted blue and is decorated with the *esgrafitado* technique, though very deteriorated, which enhances and enriches the gold leaf underneath (Figure 2).

Mantel

The outside of the mantel is blue, while the inside is red. The foliage motifs are painted in white. Although the most used decoration on the whole mantel is *estofado*, the *esgrafitado* technique is used occasionally in order to fill in the empty spaces in-between the foliage motifs. The most used decorative motif pattern is based on the acanthus leaf. This pattern enables the decoration of large areas and enriches the work with its detailed foliage. Other motifs are used in the outer area. Some of these patterns appear to be based on grapevines, while other forms resemble daffodils. In addition to daffodils, another flower forms can be seen, however these have not identified so far. The mantel displays a simple horizontal stripe, which does not cover its entire width, and the inner area shows a motif which resembles a fleur-de-lis. Both areas are bordered with an undecorated stripe and a parallel line.

Tunic

The tunic is white and decorated with the same motifs as those on the outside of the mantel. It shows a simple horizontal stripe with a line along both sides that resemble grapevines, the above-mentioned unidentified flower and acanthus leaves. The *esgrafitado* technique has been used in the areas around the foliage motifs.

Base

The original base would have been red, but it has been subject to restoration treatments in the past and is now repainted grey. The stratigraphic sample collected in that area proves that an original red paint layer can still be found in that area.

Acknowledgements

English language version by Fátima Paiva.

Please use the following when citing this paper:

A peculiar association of structural construction and polychromy from the eighteenth century. Our Lady of Immaculate Conception, Sacristy of Church Madre de Deus, Museum of Azulejos, Lisbon.

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Our Lady of Immaculate Conception was restored in the Conservation and Restoration Department of the IMC (currently called Laboratório José de Figueiredo-DMCC-DGPC) in 2009. No documentation referring to this sculpture has been found. The name of the artist and the year of execution is unknown. Material-technical information resulting from diagnosis and multidisciplinary analysis was used to determine the artists’ creative process. This information aided in understanding the conservation condition of the object and decision-making for conservation. Wood identification, the components of the structure, subsequent additions, tool marks, pigments and binders were identified. The analyses carried out were X-radiography, micro-Fourier Transform Infrared microscopy, X-ray Fluorescence Spectrometry and cross-section sampling.

The study of the structure of the sculpture and its polychromy leads to questions about the contemporaneity of the decorative layers and about the collaboration between sculptors and painters studios. The good quality of the carved work, in particular the falling folds of the robes and the subtle movement of the Virgin's head and body, suggest that this is a work of the late baroque period. Both the Virgin and the glory of angels surrounding her have glass eyes inserted in hollow spaces, created by scooping out sections from the wood block at the revers of the heads. The X-radiographies show evidence that the wood in the lower part of the globe split, presumably caused when the wood dried out after felling. Numerous spikes strengthen the large crack and other elements. The X-radiographies also show areas of filling distributed all over the sculpture. All these interventions were executed before the original polychromy was done.

The sculpture has one original polychrome decoration, which covers original divisions in the support construction. The surface was gilded, with both silver and gold leaf, and decorated using a sgraffito technique. This careful and delicate working method is noticeable in the fine details. However, it is unclear if the pigments used are contemporary with the carving. The use of lead white and ultramarine blue could indicate that the polychromy dates from the eighteenth century. Some of the aspects of the decorative work show a later style.

Please use the following when citing this paper:

The subject of this analytical study can be found in the sculpture collection of the National Museum of Soares dos Reis (Porto, Portugal). The polychromed, wooden sculpture represents a Crucified Christ. It is currently dated in the thirteenth or fourteenth century, although there are several dating and origin issues that remain unclear. The prevailing notion was that this work would have a Spanish origin, more specifically from the region of Catalonia, largely due to the formal and stylistic similarities with the medieval Catalan sculptures of Christ in Majesty produced in that region. This poster aims to present the scientific study of this wooden sculpture, as well as its interpretation, since it is of high importance to characterise with precision the historical context, the applied materials and the technological characteristics in order to better understand the object. The study will also be useful regarding the possible conservation and restoration project, which is necessary because of the degrading state of the polychrome layers. For this purpose, the material technical information was provided by the following scientific tools: micro-sampling of the polychromy and the support, stratigraphic analysis by Optical Microscopy (OM), Scanning Electron Microscopy coupled with Energy Dispersive X-ray Spectroscopy (SEM-EDX), micro Fourier Transform Infrared Spectrometry (µS-FTIR), micro X-Ray Diffraction (µ-XRD), and morphological identification of the wood by optical microscopy.
Table 1. Results of the stratigraphic analysis.

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<th>Materials</th>
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</thead>
<tbody>
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<td>10</td>
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</tr>
<tr>
<td></td>
<td>L4 - Red</td>
<td>Lead white + Calcite + Oil</td>
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<td></td>
<td>L2 - White</td>
<td>Lead white + Oil</td>
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<td>13</td>
<td>L7 - Red</td>
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<tr>
<td></td>
<td>L6 - Pink</td>
<td>Lead white + Oil + ?</td>
</tr>
<tr>
<td></td>
<td>L4 - Organic</td>
<td>Wax</td>
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<td>L3 - Red</td>
<td>Lead white + Oil + Wax</td>
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<td>Lead white + Calcite + Prussian blue + Oil</td>
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</table>

Please use the following when citing this paper:
The influence of decorative motifs used in Alentejo architecture on the decoration of the sculpture Anjo Custódio de Portugal.

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Since antiquity, the decorative motifs applied in architecture have also been used in other art forms, always demonstrating strong regional influences. The esgrafito patterns used in Alentejo is very diverse and inspired by the appearance of the local flora. This type of architectural decoration was often used both inside and outside buildings, on roofs of churches and in palaces. A polychrome wooden sculpture, dating from the sixteenth century, is currently [2013] under study and treatment in the conservation laboratory of the Polytechnic Institute of Tomar. The work is from Fronteira, a small town in the Alto Alentejo, and represents thematically the Anjo Custódio de Portugal (Figure 1). The technique used in the decoration of the drapery is estofado. The draperies are divided into three, overlapping, high-waisted coats, each of them displaying a different decorative pattern. The knee-length garment has a different decoration, which can be described as an estofado with esgrafitado, and contrasts with the yellow colour observed on top of the metal leaf.

Figure 1. Left. Anjo Custódio de Portugal with estofado and esgrafitado. © IPT
Figure 2. Right. The influence of architectural decorations. © IPT
All draperies have a different colouration. In the upper mantle the golden motifs stand out against a bright red background. On the middle garment, the motifs are barely visible but the main pattern can be distinguished. This is composed of floral motifs, in gold leaf on a dark-blue background.

It is, however, not possible to identify the plant species represented in most of the decorative motifs. This is because each artist uses a particular, individual manner of depicting the flora from Alentejo, using flowers and leaves, with repetition of the pattern and done with great detail. This technique has been used in Alentejo for centuries, mainly in the region of Évora, such as in Moura, Montemor-o-Novo or Vidigueira.

In the case of the decoration of the drapery of Anjo Custódio de Portugal, there is once again the influence of the esgrafitos typically applied in architectural decorations, mainly because of the flora-inspired design used by the artist (Figure 2).

Please use the following when citing this paper:

Structural modification of an altarpiece towards its preservation.

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The main topic of this research emerged during the conservation treatment of an altarpiece, which can be found in the St. Francis Church of Oporto. It consists of a granite sculpture representing St. Francis of Assisi (Figure 1). The altarpiece can be dated around the late eighteenth century or early nineteenth century, is placed in a round arch and decorated with neoclassical elements, such as columns with a plain shaft, wreaths and a medallion.

In order to carry out the conservation of the altarpiece, it became necessary to access its reverse and thus to remove some of its elements. Due to the large amount of debris in that area and the infiltration of humidity, the wooden bars of the base had rotten and needed replacement (Figure 2). Thus, it was necessary to create some form of access to the space between the church wall and the altarpiece.

The intervention began with the removal of the wooden boards inside the niche (surrounding the sculpture) and the front wooden board of the base. These parts did not undermine the stability of the structure and were easily accessible by anyone who might have to inspect its reverse side in the future. After cleaning, damaged elements were replaced. A system of angles,
bolts and nuts of stainless steel was created to stabilise the altarpiece against the wall and to allow the easy removal or insertion of the wooden boards. These stainless steel elements are known to be strong, physically and chemically stable, reversible and easily replaceable. They are placed in a way that they are hidden but easily discernible to a trained person who might have to inspect the area. But this system has one disadvantage. To be able to access the back, the very heavy granite sculpture has to be moved.

The wooden board of the base was fixed with very thin stainless steel screws, which were almost imperceptible aesthetically, but easily noticed on closer examination. The old, degraded wooden bars were replaced with three hundred years old Scots Pine joists, provided by the Saint Francis Order.

Since the number of publications on this topic is very scarce, it was fundamental to exchange ideas with other professionals and to adapt different materials to the specific characteristics of this altarpiece. The main objective of this paper is to contribute to the research on this topic and to encourage the publication of further information on structural modification of altarpieces, in order to their preservation and maintenance.

Please use the following when citing this paper:

Polychrome technique of the Antequeran sculptor Andrés de Carvajal.

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Introduction
Antequera is a town in the agrarian entourage of the Málaga zone. It is located at the crossroads of the two well recognised Andalusian artistic styles of Sevilla and Granada. The sixteenth and seventeenth centuries were marked by the construction boom of convents and churches. The artistic splendour of the city continued during the eighteenth century. All these premises needed to be filled with artistic manifestations, such as altarpieces. These were designed with a specific iconography in mind in order to be used as a religious representation for the people attending the liturgical events. Several artists came and remained in the town, where they developed their careers and professional activities. Amongst them was Andres de Carvajal y Diego Márquez y Vega, who was also the most prolific.

Many works of art originate from these prosperous years. The sculptures of Carvajal are particularly admired by experts, mainly because of his good artistic-technical skills, and secondly, for the richness of his work (Figure 1). The prodigious amount of production represented a third of the total baroque sculpture produced in the area of Antequera in a short period of time. Furthermore, Carvajal exported his work to border cities as Estepa, and Osuna.

Development
The three keys to the identification of the polychromy of his sculptures are presented in this paper. The work of Carvajal can be easily recognised by the following aspects, namely working procedures, iconographic models and decorative motifs.
Working procedures

Carvajal used three working methods to build the polychrome layers of garments or draperies. In the first method, the polished, gilded and punched layer covers the complete surface. The decorative motifs are made with brushes. In the second method, the polished, gilded punching is not covering the surface of the garments. It is used only for the decorative motifs, which are also individually painted by brush. The third method is the most complex one. The polished gilding covers the surface and a paint layer or sgrafitto layer is applied on top of this layer. However, the punching decoration is only applied to create the decorative motifs.

Iconographic models and decorative motifs

There are three iconographic models. San José wears a blue robe, which is decorated according method two or three. For the mantle, method one is used. For female sculptures, the method is exactly the opposite. Further, sculptures of saints wear habits which are polychromed according method two. These works of art have less artistic quality.

The decorative motifs used by Carvajal are fruits, bulbs, flowers, and polygonal shapes (Figure 2).

Results

By studying the three keys mentioned above, the personal style of Carvajal can be easily recognised. He had a deep impact on the sculptors of the following years in the region. His workshop had been the most important of the town during the first part of the eighteenth century. Visibly, the artistic style of this master is characterised by a mix of decorative motifs and precise methodology, strictly adapted to the iconography needed.

As a conclusion we can say that the polychromy of Carvajal is characterised by exclusive elements from own production, such as polygonal shapes, specific volumetric effects and the polished, gilded, punched layer with brushed details which covers the complete surface. These elements cannot be found in the production of Diego Márquez y Vega, his contemporary and direct competitor. The discrepancy allows us to identify and attribute new sculptures to the workshop of Carvajal.

Please use the following when citing this paper:
Picasso’s influence on Italian art was great after the Second World War. Sculptors as well as painters, found in his work an inexhaustible source of inspiration [1]. Marino Marini (1901-1980) and Leoncillo Leonardi (1915-1968) were among the major Italian sculptors of that time. Notwithstanding their differences, it is interesting to compare their conception and use of polychromy in that period as a way to face and recreate the revolutionary pictorial approach of Picasso.

Marino Marini started his career at the end of the 1920s, and his focus on polychromy was influenced by the painted surfaces of the recently rediscovered Etruscan tombs and sculptures. Featuring a great curiosity towards various artistic sources from all over the world, he added to the major interest in Etruscan art the update to the artistic sources from the farthest areas, such as the Chinese Tang Dynasty ceramics and medieval wooden sculpture. The many sculptures Marini made on the subject of the horse and rider point out the key role played by the ancient sources in the reception and interpretation of Picasso’s legacy [3].

Little Rider is a polychrome terracotta made in 1942 [Carandente 1998, 124-125]. The artist applied layers of colour directly on the surface, without any preparation underneath. The use of strokes to shape the essential structure in the forms echoed Picasso’s late cubist work of the 1930s, whereas the use of subtle colours, the geometric decoration of the rider, and the overall effect of opacity refer to archaic objects, namely Etruscan terracottas. Marino Marini resorted to this artistic background in his larger size work as well, such as in the famous Rider (The Town’s Guardian Angel), made in 1949 [Carandente 1998, 236-237]. As usual in Marini, there are many versions in different materials, one of which features polychrome wood, a favoured material for the larger scale sculptures from the beginning of the 1930s. The artist drew the iconography of the upright Rider and the use of wood from medieval sculptures of Northern Europe. However, Marini applied colour in an unusual way compared to the traditional medieval technique of polychromy. In fact, as in the above mentioned small terracotta, the artist did not apply any preparation layer underneath the polychrome layers, so the rough wooden surfaces are visible through the colour. This effect recalls another ‘primitive’ source, namely the polychrome Sub-Saharan wooden idols. By using a very essential palette of earthy tones and highlighting the basic contours of the figures through bold dark lines, the artist conveyed the sense of a pure, quite geometric structure underneath the figurative subject matter. The ‘abstract’ concern for the structure of reality was a key issue in the heritage of Picasso’s cubism in postwar Italy, that Marini precociously showed in his work. The iconography itself, linked to the symbolism of the surviving western tradition after the tragedy of the war, is akin to the social engagement conveyed by Guernica, the most renowned work by the Spanish master.

In the same years, in Rome, Leoncillo Leonardi made two sculptures, Telephone Operator and Typist [4] [Carloni 1979, 117-118]. The technique is really different from that used by Marini. In fact, they are polychrome enamelled terracottas, featuring different concerns for decoration and sculpture. Marini was older than Leoncillo, and considered his work within the ‘classic’ opposition between the practices of painting and sculpture, so he conceived polychromy as basically a sort of three-dimensional painting. Significantly, he was a prolific painter and draftsman [5]. On the other hand, Leoncillo belonged to a younger generation, so he was more experimental in techniques and practices. In fact, the conception and practice of making three-dimensional polychrome sculpture was closely related to the sculptural technique itself. While Marini was basically a sculptor, Leoncillo’s work stood at the crossroads between fine and applied arts. He was a talented ceramist thanks to a long training in producing ceramic pieces of
Leoncillo chose ceramic at the beginning of his career, in the second half of the 1930s. Ceramic was the only technique through which to convey a sense of tonal density in round sculpture (the colour is more transparent in his glazed terracottas, more opaque in the enamelled ones). The artist’s concern for colour was influenced by the artistic context he would be in touch with soon after moving to Rome from his birthplace. The art world in the city during the 1930s was featured by the expressionist painters and sculptors of the so-called ‘Scuola Romana’, by Scipione or Fausto Pirandello for example. Telephone Operator and Typist are dated in 1950, and show the later outcomes of Leoncillo’s work within an artistic context of that kind. They belong to a series of sketches and variants focusing on subjects taken from everyday work and life, which were linked to the artistic debate about socially engaged realism after the Second World War. The medium size and the technique were also meant to renovate the Italian tradition of ceramic in the renaissance and baroque. The relationship with baroque art is more evident in the artist’s earlier work and was typical of the artistic context in Rome that influenced Leoncillo [6] [Catalano 2011].

By this technique, the artist provided an original interpretation of Picasso’s influence that featured most of the artistic trends in postwar Italy. The artist opened to the environment the cubist structure of the two sculptures, made of flat pseudo-geometric colourful surfaces, through the bright palette of colours and the effects of light conveyed by the typical reflecting surfaces that only the moulding in enamelled ceramic can create. In the work of Marini the figures seem abstract archetypes, while in Leoncillo they have a body or a weight, they are exposed to light and atmosphere and seem to be made of a kind of colourful flesh, although colours and forms are not strictly ‘realistic’.

As mentioned, Leoncillo also made ceramic pieces of furniture, like chimney pieces. The concern for polychrome sculpture was rooted in his awareness of the traditional decorative function of polychromy in architecture. By renovating a traditional renaissance technique through the

Figure 1. Left. Marino Marini, Little Rider. 1949-50, polychromed wood, 180 x 107 x 107 cm, Komaki City, Komaki, Aichi, Menard Art Museum. © Fondazione Marino Marini, Pistoia/Menard Art Museum, Komaki City, Komaki, Aichi.
Figure 2. Right. Leoncillo Leonardi, Typist. 1949, front, Polychromed and enamelled terracotta, 72 x 40 x 16 cm, Faenza, International Museum of Ceramics. © Museo Internazionale delle Ceramiche, Faenza.

Polychrome Sculpture: Decorative Practice and Artistic Tradition

influence of Picasso’s cubism, the artist created a truly ‘environmental’ sculpture. In fact, he conceived the figures of his work as opened to the surrounding space and the light and represented them as architectures of coloured surfaces and volumes. The decorative elements in Telephone Operator play this role, and demand a unique point of view as if they were made for a decorative panel to hang on a wall, as in traditional Italian reliefs made in enamelled terracotta during the sixteenth and seventeenth century.

In conclusion, Marino Marini and Leoncillo Leonardi represent two really different ways of making and employing polychromy in twentieth-century Italian sculpture, even though the two artists both reacted to the shocking spread of Picasso’s modern mastery by enhancing the traditional concerns and practices of sculptural techniques of ancient, western and non-western art.

Endnotes

[1] An essay dealing with the widespread of Picasso’s work among the Italian sculptors after the exhibition of Guernica in 1937 has not been published, however some references could provide insightful points of view on the most relevant ways through which the Italians reacted to the work of the Spanish master, such as [Mantura et al. 1998] [Barbero et al. 1997].

[2] Unfortunately, the bombings over Milan during the Second World War destroyed the artist’s studio, so most of the work and the library kept there had been lost (see the artist’s biography in the catalogue raisonné) [Carandente 1998, 343]. Nevertheless, the museum of the sculptor in Pistoia, Tuscany, holds the books the artist gathered until his death, spanning the sources of his interests and concerns (i.e. Etruscan, Medieval and Chinese art) [Sauerlandt 1926] [Ducati 1941] [Goldscheider 1941]. Earlier critics such as Lamberto Vitali pointed his interest in ancient Chinese art [Vitali 1937, 18-19]. To have an insightful view of Marini’s activity and sources, see the essays authored by Marta Patti and me [Giusti 2012, 41-65, 107-125] and the recent catalogue of the collection of Marino Marini’s work at the Museo del Novecento in Milan [Fabi 2015].

[3] As discussed Marini’s approach is highly influenced by Picasso’s art [2] [Giusti and Salvadori 2012, 107-125]. Marini knew Picasso in person, and saw his work many times. Just to mention one relevant source about Picasso’s work, the artist’s library includes the huge book about Guernica published by Curt Valentin and gifted by the dealer to the artist [Larrea 1947].

[4] A full and reliable entry about the works has been published in the catalogue of the retrospective exhibition organised at the Galleria Nazionale d’Arte Moderna in Rome in 1979 [Carloni et al. 1979, 46-47, 117-118].

[5] The critics found the most insightful links between the work of Leoncillo and contemporary painting since the beginning of the sculptor’s career [Mora 1947] [Longhi 1949]. Although his work has been so relevant within the artistic context in postwar years, an exhaustive scholarship about Leoncillo is still missing. Actually, the catalogue of the 2002 exhibition in Matera is the major source on his life and work [Appella et al. 2002]

[6] An interesting interpretation of the artist’s approach to polychromy and matter through his own words is provided by Maria Ida Catalano [Catalano 2011].

References


Please use the following when citing this paper:
Integrated innovative study of the polychrome decoration of a Czech medieval statue entitled The Mourning of Christ.

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One of the basic conditions of being able to start the project concerning the rare medieval polychrome sculpture entitled The Mourning of Christ had been a detailed analytical investigation (Figure 1) [Fogaš and Hlobil 2012]. The sculpture, owned by the convent of Minorits in Brno (Czech Republic), is a complex work of figurative woodcarving, comprising eleven male and female characters standing around the laid body of Christ (representing an iconographical scene occurring after the Descent from the Cross). It is shaped in high relief (97 × 136 × 29 cm) and made of four solid lime wood blocks assembled together, with several supplements. It can be dated around 1520. Unfortunately, most of the individual sculptures have been damaged and show many repaints, which date probably from the nineteenth and twentieth century. There are missing parts, such as a finger or incarnate layers, extensive abrasions and cracks. These damages, however, provided ample sites for sampling. In total, twelve samples were taken from the sculpture and were embedded to make cross-sections [Kuckova et al. 2013].

The extremely complex stratigraphy of the polychrome decoration required the identification of inorganic constituents and the precise identification and localisation of organic binders. The exact interpretation of all components is very important to determine the original painting techniques, the presence of overpaints or other later interventions, and the detailed history of the artwork.

The goals of this research were 1) to describe the inorganic and organic composition and the stratigraphic structure of the paint layers, by means of Optical Microscopy (OM), Scanning Electron Microscopy-Energy Dispersive X-ray Spectroscopy (SEM-EDX) and micro-Raman Spectroscopy to characterise the materials and techniques and eventually to determine the
provenance of the artwork 2) to identify and localise the presence of the organic binders in the paint layers 3) to compare two mass spectrometric techniques, namely Matrix-Assisted Laser Desorption/Ionisation Time of Flight (MALDI-TOF) and nano-Liquid Chromatography coupled with Mass Spectrometry (nano-LC-ESI-Q-TOF), in order to identify the proteins of the used binding media. Until recently, the mapping and identification of proteinaceous binders in small samples taken from artworks was very complicated and nearly impossible in the case of analyses of cross-sections. This poster presents the combination of the results concerning staining tests (Oil Red O and Sypro Ruby) and the two mass spectrometric techniques (which were performed on cross-sections of polychrome samples). Thus, the presence of egg and animal glue proteins together with oil-based materials was successfully detected and their position within the complex multilayered structures of the polychrome artefacts was established.

![Figure 1. The Mourning of Christ. Marked are the sampling areas of the twelve samples. © Minorits in Brno](image)

SEM-EDX and micro-Raman Spectroscopy reveal that the ground layer was made of ‘marine’ chalk that contains the remains of microscopic calcareous nanofossils of eukaryote phytoplankton called coccoliths (Figure 2). The presence of these nanofossils in the ground layer could not help with the attribution of the place where the statue was made, because they are the common components of the calcium carbonate sediments and used all around medieval Europe. Other identified inorganic pigments (e.g. lead white, vermillion, ultramarine) were also commonly used in the middle ages. Others as Co-based pigment and barite were more recently used and they were attributed to the intervention of overpainting. The provenance of the artwork could not be determined with certainty.

Based on the detailed analyses, it was decided that the artistically high quality of the late gothic overpaints is sufficient to maintain an authentic appearance of the artwork. The identification of the binders, pigments and fillers in different layers of the samples, allowed the restorers to compositionally and stratigraphically characterise the decoration of the sculpture and to assess the presence of historically known techniques (paint and gilding techniques). This knowledge is useful for further selection of the most appropriate restoration treatment.
Acknowledgements

This work has been supported by Fundação para a Ciência e a Tecnologia through grants no. PEst-C/EQB/LA0006/2011 and no. PTDC/EAT-EAT/116700/2010 by EU funds, project Operational Program Prague–Competitiveness (OP PC) CZ.2.16/3.100/22197, Grant No. 000746 from the Czech Ministry of Culture 000746, Grant No. 6046137305 from the Czech Ministry of Education, and by Financial support from Specific University Research (MSMT No. 21/2011) in Prague.

References


Please use the following when citing this paper:

The study of the polychromy of the Pórtico de la Gloria, Cathedral of Santiago de Compostela, Spain.

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The Cathedral Program was set up in 2006, after the signing of a collaboration agreement between multiple institutions, namely the Chapter of the Cathedral, the Archiepiscopate of Santiago, the Barrié Foundation, the Ministry of Culture and the local government, the Xunta of Galicia. Since 2010, the Spanish Institute of Cultural Heritage was responsible for technical direction, with the support of an international Scientific Advisory. The program includes Compostela’s Cathedral most emblematic works, namely the Capilla Mayor (Main Chapel), and the Pórtico de la Gloria (Figure 1). The Portico de la Gloria’s Conservation and Restoration Project is being executed in three separate phases. At this moment, the two first phases are concluded and have allowed us to study in greater depth this twelfth-century, romanesque artwork, identifying and evaluating the deterioration risks concerning the structure, the materials and its use as a monument.

Figure 1. Left Main figures from the Pórtico de la Gloria from the Santiago de Compostela Cathedral. © Spanish Institute of Cultural Heritage.  
Figure 2. Right. Detail of an applied-brocade órtico de la Gloria from the Santiago de Compostela Cathedral. © Cathedral of Santiago Program.

An investigation of the transformation process concerning the decorations of the Pórtico have been carried out. The main objective was to identify the different polychrome phases that have taken place during the past centuries. Documentation and historical research have been undertaken, followed by a non-invasive examination of the decorative techniques. Samples were taken and analysed in the laboratory, characterising the original materials (preparations, pigments, binders, adhesives, finishes), as well as the alteration products and the added materials of previous interventions. The information resulting from the analysis were combined with the
historical data, obtained through documentary research, the existing knowledge about the visible techniques (estofados, brocados) and the decorative motifs (Figure 2). It was possible to establish a chronological hypothesis identifying three general polychromes, in addition to other more recent partial proceedings.

Please use the following when citing this paper:
A considerable legacy of romanesque panel paintings from the twelfth and thirteenth centuries are still to be found in Catalonia, Spain. The panels were originally considered to embellish church altars with iconographic themes taken from biblical sources. The collection of these altarpieces is unique, due to both the number of specimens preserved, and their historic-artistic quality.

These works have been thoroughly studied on an iconographic and stylistic level since the end of the nineteenth century. However, the materials used and their support structures need further investigation. This study focuses on the wooden support of the sculptural altar frontal from Sant Pere de Ripoll (Figure 1).

This piece displays the most characteristic layout of Catalan romanesque altar frontals, with a central area flanked by twelve arched compartments, six on either side, spread over two rows. It is decorated with attached relief sculptures representing the apostles. The four symbols of the Tetramorph around the mandorla in the central register are missing, and eight of the twelve apostle figures are also lost.

The artist is unknown, as is often the case for that period. Some art historians have attributed the work to the Vic workshop, although most recent studies link it to the artistic production coming from the Ripoll monastery, a hypothesis confirmed by the findings on the support structure presented in this paper.
The original frontal dates from the twelfth century, while the dust cover and side wings are later additions, dating from the thirteenth century. The materials used are tempera paint applied to the willow-wooden, sculptural relief, which in turn is attached to an oak and Scots pine (Pinus Sylvestris) panel. The supporting structure reveals two well differentiated building stages; one from the twelfth century, and the other from the thirteenth century. The support of the original twelfth century frontal is formed by six vertical boards, making up the central panel, which are enclosed by four wide laths acting as a frame (Figure 2). On the front side, the central panel exhibits wood reliefs that are later additions. These are the strips separating the scenes, the banding encircling the mandorla, and five figures. It is unclear at what point in time these reliefs were included. In the thirteenth century the altar frontal underwent an enlargement intervention in which a dowelled dustcover frame was attached to the front of the pre-existing frame. Also two side wings were added.

Figure 2. Mortise and tenon joint, detail of the reverse. © Sant Pere de Ripoll

Two polychrome layers from different periods are present. The more recent one, from the thirteenth century, contains pigments such as cinnabar, azurite, malachite, and lead white. The gilded areas are created by applying coloured glaze on tin leaf. Underneath this polychrome layer and below the ground layer of this level, there is an earlier pictorial layer from the twelfth century.

It is possible that the twelfth century frontal was flat, without any sculptural relief, and polychromed. Later on in the thirteenth century, it was renovated to grant the piece a more modern look. Then, the dustcover, reliefs and side wings were attached to the original frontal, nailed to the support on top of the existing polychromy. Probably, a ground layer was applied to the whole top surface of the frontal and then polychromed again.

The significance of this study lies in the fact that the wooden support of the altar frontal provides key information for interpreting and comparing similar typology pieces among each other. The study of the type of wood, the structure, the joinery techniques and the tool marks allow us to make logical associations that highlight relevant information for understanding the frontals and their production. This new information is a complement to the information provided by the study of the polychrome layers.

Please use the following when citing this paper:

Proposal for an analytical methodology to study gilded woodcarving techniques and materials.

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This paper proposes a methodology for an interdisciplinary, analytical study of gilded woodcarving (talha dourada) altarpieces in Portugal as part of the three-year and a half research project entitled ‘Gilt-Teller. An interdisciplinary multi-scale study of gilding techniques and materials in Portugal, 1500-1800’ [1].

More than forty altarpieces located in Portugal and belonging to several dioceses are being studied in the above mentioned project, to be able to determine the used materials and techniques of the gilding process [Sandu et al. 2010]. Several samples were taken of each altarpiece and analysed, using an interdisciplinary, multi-technique and multi-scale methodology. In addition to several commonly used conventional techniques, such as Stereo-microscopy, Optical Microscopy (OM), Scanning Electron Microscopy (SEM), Fourier Transformed Infrared Micro-spectroscopy (FTIR), micro-Raman Spectroscopy, X-ray Diffraction (XRD), X-ray Fluorescence (XRF), other more innovative techniques, such as Matrix-Assisted Laser Desorption Ionisation-Time of Flight-Mass Spectrometry (MALDI-TOF-MS) and Enzyme-Linked Immune-Sorbent Assay (ELISA), together with fluorescent dyes, Atomic Force Microscopy (AFM) and micro-Computerised Tomography (µ-CT) were applied in order to better characterise and understand the gilded or polychrome samples.

The surface characterisation techniques, such as OM, SEM and AFM, together with micro-CT, create a complete system to research gilded layers and interfaces at different scales, namely Macro, Micro and Nano [Sandu et al. 2011]. Analytical data, in the form of images and videos, were obtained to be used in the creation of an online multimedia tool for presenting the results. The
novelty of the research methodology is based, not only on the use of non-conventional techniques (AFM, micro-CT, MALDI-TOF-MS), but also in coupling different techniques for further insights in the materials and polychrome techniques of wooden artefacts. For example, the use of MALDI-mass spectrometry, together with the fluorescent staining for protein localisation and identification directly on cross-sections, was proposed by members of the working group of this project [Kuckova et al. 2013].

This overall methodology of research of materials and techniques should lead to a series of answers to the following questions:

1. What is the chemical composition of each layer (from the ground to the final finishing varnish or glaze)?
2. What are the original materials and layers and which ones were added during later interventions?
3. How do gilding techniques and materials vary, according to different municipalities within Portugal and to different time periods?
4. Were the criteria stated in the original contract order (when available) of each altarpiece respected during its execution?

Other issues and details might arise as the authors try to answer each question, depending on the typology and complexity of the studied gilded woodcarving, such as the correlation between the
inner structure of the sample and its compositional features (investigated by micro-CT and SEM-EDX) and also its surface characteristics (analysed by AFM, SEM and OM). The complementary use of mass spectrometric and spectroscopic techniques, in combination with the staining tests and enzyme-linked immune-sorbent assays, also allow defining the distribution, localisation and identification of organic materials (binders, sizing layers, varnishes) in the stratigraphy of the analysed samples.

This methodology also includes the creation of a database of analytical results, to be available online as a multimedia tool. For this purpose different analytical data sheets were created for the structure of this database in order to better summarise the results, allowing further access to a specialised and non-specialised public.

Acknowledgements
This work has been supported by Fundação para a Ciência e a Tecnologia through grants no. PEst-C/EQB/LA0006/2011 and no. PTDC/EAT-EAT/116700/2010.

Endnotes

References


Please use the following when citing this paper:
Changes in the original decor

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Introduction

St. Sebastian and St. Vincent, two polychrome wooden sculptures belonging to the Cathedral of Silves, show signs of degradation. Their current inadequate state of conservation meant that they were placed in storage away from the eyes of the community to which they belong.

The current surface layers are a combination of applications dating from old restoration interventions applied over the centuries. These older restorations do not conform to current practice inherent to modern day conservation and restoration ethics and changed the appearance of the sculptures dramatically.

The treatment carried out at the Polytechnic Institute of Tomar as part of a Masters in Conservation and Restoration involved preservation and conservation of the two sculptures.

St. Sebastian

Dimensions: 79 cm x 23 cm x 89 cm

Author: unknown

Technical Production / Materials: polychrome wood carving of a single block. San Sebastian is a work characteristic of late-Gothic period, which has undergone many changes over the years.
**St. Vincent**

Dimensions: 107.5 cm x 29 cm x 37 cm

Author: unknown

Technical Production / Materials: polychrome wooden figure in the round, carved in a single block, with one removable arm. The polychrome visible is not the original.

**General Observations**

The upper most paint layers of both sculptures do not follow the original decor. The application technique is poor and the use of materials is inferior. The later restorations have caused irreversible loss of original polychrome. However, losses in the upper polychrome layers revealed the original layers below. These were superior in both application and materials.

**Conclusion**

The presence of old restorations often complicate the treatment work. Careful mapping of these layers helped distinguish them from the underlying original layers. In addition, these later layers changed the appearance of the figures and thus the artist’s intent. It was possible to remove these upper layers in places revealing the higher quality of the original polychromy.

**Bibliography**


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