Original Gilding on Auricular Frames

Unusual gilding techniques practiced in Holland, 1640s - 1670s

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Introduction

Many seventeenth-century Dutch painters have depicted interiors with ornately carved gilded picture frames.[1] In their book *Framing in the Golden Age,* Van Thiel and De Bruyn Kops describe beautiful examples of frames in the so called auricular or lobate style. This style of decoration was conceived in the beginning of the seventeenth century by the Dutch silversmith Paulus van Vianen (c.1570 -1613), and further developed by his brother Adam van Vianen (c.1568 -1627), and by Johannes Lutma (1587 -1669), (figs. 2-3).[2] The auricular style, sensuous and fluid, without sharp edges, has been described as a 'fantasized decoration..., inspired by lobate forms and other parts of organisms, such as folds of skin, pieces of flesh, tendons, bones, wings and monster heads.'[3] Besides providing new shapes for silverware, the auricular style was also a major impulse for the design of carved picture

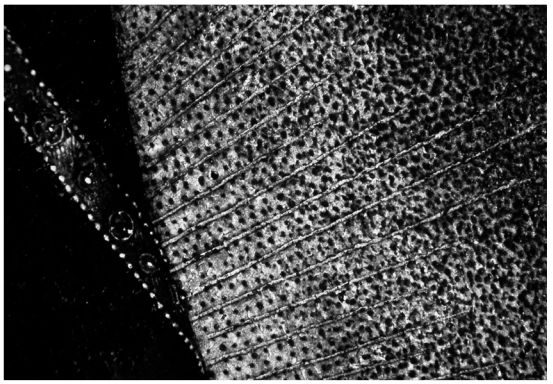


Fig.1 Roger van der Weyden, *Mary with the Christ Child*, Huntington Art Gallery, San Marino.
Detail of lines in mordant gilding over a water gilded background

Fig.2 Gilded silver ewer, Adam van Vianen, 1614, Rijksmuseum Amsterdam, BK-1976-75)

Fig.3 Brass choir gate, Nieuwe Kerk, Amsterdam, Johannes Lutma the Elder, made shortly after the fire of 1645 in the church

frames, furniture, glass and architectural elements from the 1640s through the 1660s in Northern Europe.[4] Original gilding from this period is now exceedingly rare and this makes it difficult to tell by which methods these frames were once gilded. The gilding on ten auricular frames from Dutch collections was examined with Polarized Light Microscopy (PLM), Scanning Electron Microscope Energy-dispersive X-ray spectroscopy (SEM-EDX), samples were analysed using michrochemical analysis, Fourier Transform Infrared micro spectroscopy (FTIR), Gas Chromatography-Mass Spectrometry (GC-MS), and Direct Temperature-resolved Mass Spectrometry (DTMS). The results, presented in this article, revealed that a rather unconventional gilding technique was used in Holland during the middle of the seventeenth century.

- *Traditional gilding techniques*

There are two traditional ways to apply gold leaf on wood, water gilding and mordant gilding (usually oil gilding). Both techniques require specific preparation of the substrate before any actual gilding can take place. In order to achieve a convincing illusion of solid metal by applying gold leaf, it is essential that the wood be treated in such a way that its surface is smooth and its grain no longer visible. Therefore the carvings are scraped and sanded to obtain a certain degree of smoothness. Next, the wood is given a coat of glue size. This glue was made by boiling animal skins to a proteinaceous jelly. It reduces the absorbency of the wood, preventing it from soaking up the binding medium of the following ground layers. The wood is then typically prepared with a 'ground', consisting of inorganic filler, such as chalk or gypsum powder with glue binder.[5]

With this ground dry and scraped to ivory-smoothness the actual process of water gilding could begin. Water gilding (also called bole gilding) has a long history, going back 4,500 years to ancient Egypt, and has been practiced in virtually the same way since the middle ages. In this method a thin layer of clay (called bole), mixed with glue, is allowed to dry as the last preparation on the object. Bole is soft, greasy-textured clay, usually orange or reddish brown coloured. It is ground in water and, mixed with dilute skin glue, brushed on as a thin reddish paint. When dry, it was burnished or polished up with a piece of cloth to ensure a smooth, grit-free cushioned surface. Water is then used to reactivate just enough of the glue in the bole to bind the extremely thin gold leaf. Each gold leaf is at first literally floating on a film of water. After the water is absorbed and partially evaporated there is a critical time window during which the thin layer of clay is just flexible enough for the gilded surface to be burnished to a high gloss.

Mordant gilding was often used in the final stage in the execution of a painting. It served for the embellishment with lines of gilding in the imitation of gold embroidery. Small pieces of gold were laid on to an adhesive or mordant applied to the areas to be decorated. The term mordant describes a group of sticky substances used for adhering gold leaf to a surface. The most common mordant was a molasses-like composition of thickened linseed oil mixed with a little varnish and some metal salt that was added for drying. Oil gilding is the most familiar mordant, but anything from lacquer, varnish and wax, to garlic juice have been used in the past. Each type of mordant has its own, usually fairly generous, time window during which it has the right 'tack' for the gold leaf to adhere. The gold leaf cut to approximately the correct size was laid over the tacky mordant. The leaf then should stick to the mordant alone. Unlike bole gilding, mordant gilding cannot be burnished to increase its shine.
On rare occasions the two methods, water gilding and mordant gilding, were combined. For example in Roger van der Weyden's *Mary with the Christ Child* (San Marino, Huntington Art Gallery), the rays of the halo's emanating from the Virgin and Christ, are done in lines of mordant gilding applied over the water gilded background (fig. 1).[6]

The two different types of gilding also found their use in the gilding of frames. Before and during the sixteenth century water gilding, oil gilding and polychromy were commonly used on frames in the Low Countries. Around the end of the sixteenth century and in the first half of the seventeenth century we see mainly a sparing use of oil gilding on black profile frames. Ebony veneer frames, made since the beginning of the seventeenth century, were sometimes partly gilded with oil mordant along the sight edge.

An exceptional technique
On Dutch frames and furniture in the auricular style, however, the original gilding may have been of a different kind. Some of these objects do not show the regular features that one could expect of water gilding, nor that of mordant gilding, This new technique appears associated with gilded frames and pieces of furniture, that were made in the lobate or auricular style. [7]

It appears that these objects were produced with a peculiar gilding technique. On auricular frames, and even furniture[8], we often find remains of a thick, transparent primer under the gilding. The gold leaf itself is attached by a thin layer of pale, salmon coloured emulsion paint which follows on top of this translucent primer. Few examples have survived because the novel gilding technique proved to be unstable over time, and the wood most commonly used for carving auricular frames - lime wood (*Tilia x europea*) - is quite prone to woodworm. The original gilding shows a highly characteristic angular crack pattern that runs mainly perpendicular to the grain of the wood. The priming layer tends to loose its flexibility and smoothness, and becomes hard and brittle over time, often resulting in poor adhesion to the wood and the formation of thick angular flakes that look like amber (fig. 4).

- *Research*

In order to gain insight into the a-typical method of gilding used during the middle of the seventeenth century, ten auricular frames from different collections have been investigated. All but one of these frames are gilded with a transparent primer. No historical recipes have been found to date related to this particular gilding technique. We will first discuss the detailed findings on two pairs of frames from the Rijksmuseum Amsterdam that provide us with fine examples of the technique.

The first set (inv. nr. SK-L-1005 and SK-L-1006) are 'portrait' pendants of equal dimensions. They are boldly carved of lime wood and look alike in design, combining fruits, flowers, foliage and auricular ornamentation in a manner characteristic of the 1650s and 60s (figs. 5-

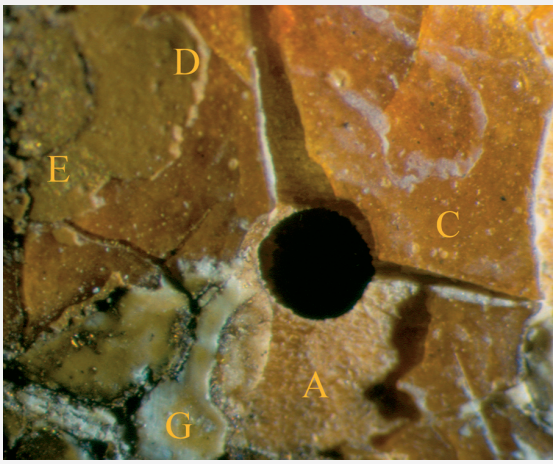


Fig.4 Macro-photograph of an auricular frame providing a characteristic close-up view of an auricular frame. The letters in the illustration correspond to the Stratigraphy.
The dark spot in the center is a worm-hole; ca. 1.5 mm in diameter – Anobium punctatum. Around it we see light coloured lime wood (A) with translucent orange flakes (C) of glue-priming. On top of the flake in the top left section there is an opaque stratum with a pale salmon colour (D).The left part of this 'island' shows light yellow specks of abraded gold leaf (E). Other wormholes have been filled with a white substance (G) during a former restoration. Rijksmuseum Amsterdam, Inv. Nr. SK-L-1005.

STRATIGRAPHY (Applies to the figures 4, 8, 11 and 12)
A. Lime wood (*Tilia x europea*).
B. Some of the frames seem to be prepared with a putty containing chalk (Ca) and probably glue, rubbed into the fibres of the surface to fill the irregularities of the wood surface.
C. A very thick layer of hide glue, measuring up to 2mm, immediately on top of the wood. This transparent, orange coloured layer shows glue with minute air bubbles, and with a characteristic cracquelure pattern with the main cracks running across the grain of the wood. It contains traces of lead white and of yellow ochre, but typically contains no filler. Elemental distributions show Chlorine (Cl) and Sodium (Na) in this layer which may indicate the use of brackish water in the workshop.
D. An opaque, salmon-coloured emulsion paint layer follows, on some of the frames atop of an intermediate oil layer, but usually directly over glue layer (C). This layer characteristically contains plenty of lead white and yellow ochre in large grains of irregular size and shape. Analysis revealed egg yolk, oil and hide glue as components of the medium. This stratum measures considerably thicker than the oil layer, but it is always much thinner than the glue layer (C).
E. Gold leaf of a warm, orange-like tint: it lies directly on top of the emulsion paint.
F. Some frames have a brown, varnish-like glaze on top of the gold. Analysis with TLC showed it to be mastic. Lanolin was also identified in this layer with DTMS.
G. Later interventions: layers of fill material, subsequent oil gilding and bronze paint from later treatments/restorations.

Fig.5 One of a pair of auricular frames, sight size 72 x 58 cm, SK-L-1006, at the Rijksmuseum Amsterdam, surrounding *Festoon of fruits and flowers*, Jan de Heem, SK-A-138

Fig.6 Detail of frame SK-L-1005, pendant to frame SK-L-1006

Fig.7 Detail of the edge of auricular frame SK-L-1005 showing a characteristic crack pattern and cupping. The yellow/orange area in the centre shows bright flecks of gold leaf which were hidden under a fill. Around the central area the glue priming was not protected by the fill: it has discoloured and most of the gold is abraded

Fig.8 Detail of SK-L-1005. Traces of a transparent brownish layer remain on the gold in protected areas after removal of bronze paint, possibly from an original glaze to tone the gold

Fig.9 An early auricular frame at the Rijksmuseum Amsterdam, SK-L-4008; overgilded, but in good condition

Fig.10 An early auricular frame at the Rijksmuseum Amsterdam, SK-L-4009; overgilded, but in good condition. Pendant frame to SK-L-4008 (Figure 9)

Fig.11 Close-up view of frame SK-L-4008 (shown in Figure 9) reveals the characteristic, translucent glue-primer with specks of gold leaf, hidden underneath a more recent gesso and oil gilding. The oil gilding is covered with a layer of grainy, discoloured bronze paint. Location of cross sample No. 108-3. See also Figures 12 - 14

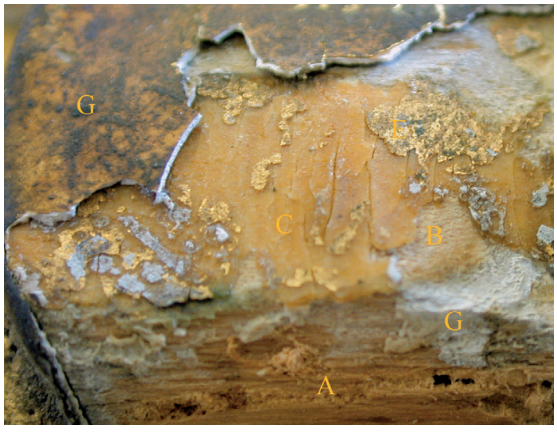
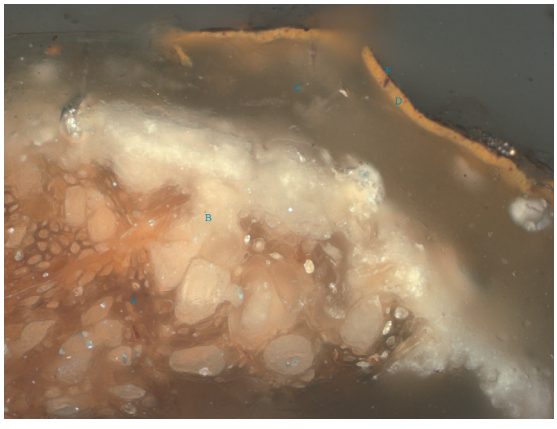


Fig.12 Frame SK-L-4008, Rijksmuseum Amsterdam. Cross section in bright field illumination, magnification 200x, sample No. 108-3



6).[9] Although both frames have been worked over with later gilding, fill materials and bronze paint, they provide a good opportunity for further investigation.

In the original technique, a thick, transparent layer with an orange tint is applied directly over the wood of the frame. In some areas this layer can be as much as 2mm thick. Over time, this layer has become brittle, cracked, cupped and is peeling off. The cracks run mainly perpendicular to the grain of the wood (fig. 7). Fourier transform infra red (FTIR) micro spectrometry indicated that this layer is a thick hide glue with negligible traces of resin. No stereates were found.[10] The presence of the resin may be due to a contamination from a later applied varnish; whether this varnish was part of the original structure cannot be determined with certainty.

The proteinaceous glue layer is covered with an opaque, salmon-coloured layer, distinctly thinner than the transparent glue layer. It contains lead white and yellow ochre pigments in large grains of irregular size and shape on some of the frames.[11] Analysis on two of the frames suggests that this salmon-coloured layer is emulsion paint. FTIR analyses suggested the presence of egg yolk, lead white and some silicate. Traces of mastic and saturated as well as unsaturated fatty acids were found with several chromatographic techniques and GC-MS.[12] Various staining techniques indicate the presence of proteinaceous and oleaginous binding media in this upper layer. This corresponds to an emulsion, for instance of linseed oil, egg yolk and animal glue.[13] Directly on top of the emulsion paint we find considerably abraded gold leaf of a warm tint. In some concave areas of the carving, which have not undergone too much abrasion, traces of a transparent, brownish-amber coloured layer remain on top of the gold. Again traces of mastic resin were found.[14] Whether this layer is original or part of a later intervention remains uncertain (fig. 8).

The second set of lime wood frames (inv. nr. SK-L-4008 and SK-L-4009) is carved in vertical format and almost identical in design and dimensions (figs. 9-10). The style is early auricular, probably from the late 1640s, with flowing 'lobes', a grotesque mouth at the top and the bottom, and a pure, abstract auricular pattern without botanical elements. Both frames have been re-gessoed and re-gilded, perhaps as early as the eighteenth century, with a thin primer and oil gilding over the original finish (fig.11). On these two small frames a slight variation in the application of the original gilding was observed. Light microscopy on samples showed that major irregularities in the wood of these frames were first smoothened by a thin application of a whitish material.[15] This material is present on the surface of the wood as well as in the larger vessels and plant (sklerenchym) cells. Apparently it was with some pressure rubbed into the structure of the wood like putty (fig.12). Elemental analyses[16] (fig. 13a) showed a concentration of calcium in this first layer. This calcium-rich material was identified as calcite.[17] A translucent, unpigmented, orange layer (200 μm thick) rests on top of the white material. The composition of this thick layer appears to be similar to the preparation layers found in all of the other examined auricular frames. Staining of a cross section with a fluorescent reagent to proteinaceous materials seemed at first only effective for the medium of the whitish material.[18] However, a subsequent staining test for proteins with fuchsinic acid gave a distinctly positive reaction on the thick, orange preparation layer too. Positive reactions were also found for oils as a positive reaction for saturated fatty acids in the glue layer was established (fig. 14).[19] This fat content may be due to insufficient cleaning of the animal skin in the original preparation of the glue. It could, however, also be intentional as it may have contributed to the working properties of the material.[20] Further analyses of this layer with FTIR micro spectroscopy showed absorption bands that matched with a protein reference.[21] Amino acid analysis (GC-MS) showed these proteins to be animal glue. The presence of characteristic amino acids – glycine, alanine, valanine, but especially proline and hydroxyproline - as well as their relative abundance, match perfectly well with animal proteins.[22] The search for remnants of oils, waxes, and resins in this animal glue layer was quite rewarding. The analysis did not show any indications for the presence of waxes or resins, nor for that of a drying oil. However, the fatty acids 2C9, C16:1, C16 and C18 in a ratio of 2.7 indicate, together with the presence of squalane, that there is a significant amount of non-drying fat or oil.[23] These fatty acids would be of a skin grease or animal fat type. Leaving some animal fat on the skin prior to the preparation of the glue, or even the deliberate addition of animal fats, would probably result in a much smoother priming layer.[24] Under the microscope the layer often showed the inclusion of a fair number of air bubbles, which could be expected as a result of entrapment of air bubbles in a vigorously stirred glue jelly. Elemental analyses (fig. 13a) revealed markedly large amounts of chlorine (Cl) in this translucent layer. For the moment we do not have a solid explanation for the presence of this element, nor for its functionality (it may be that the preparation of

the glue with sea water could improve the working properties, but experimental attempts to make glue with salty water have hardly shown advantages in working properties so far).[25] The position of this transparent layer on frames SK-L-4008 and SK-L-4009, presents a variation of the postulated auricular frame- technique, as the thick layer would normally be directly applied to the wood. A mayonnaise-like consistency of a fat-containing glue jelly alone could be sufficient for an effective filling and smoothening of the wood texture. The application of chalk, rubbed into the plant cells would be redundant.

Above the thick, translucent layer is again a much thinner pigmented layer that shows the presence of high concentrations of iron (Fe) and silicon (Si), indicating an earth pigment (iron oxide) in a matrix of aluminium silicate (figs. 13-14). This layer is similar in composition to the salmon-coloured emulsion paint of the uppermost layer of frames SK-L-1005 and SK-L-1006 described above.

On top of this, an extremely thin, layer of gold (Au) is present (fig.13). Above the gold there is a spot that marks positive for copper (Cu) and zinc (Zn). This is attributed to the presence of a much later, not original restoration with so-called 'bronze paint'; a common touch-up material for damaged gilding.[26] The irregularly shaped showing of carbon (C) in figure 13 on the bottom part of the sample corresponds to the organic material of the substrate (wood). The carbon at the top is in the embedding material used for the sample.

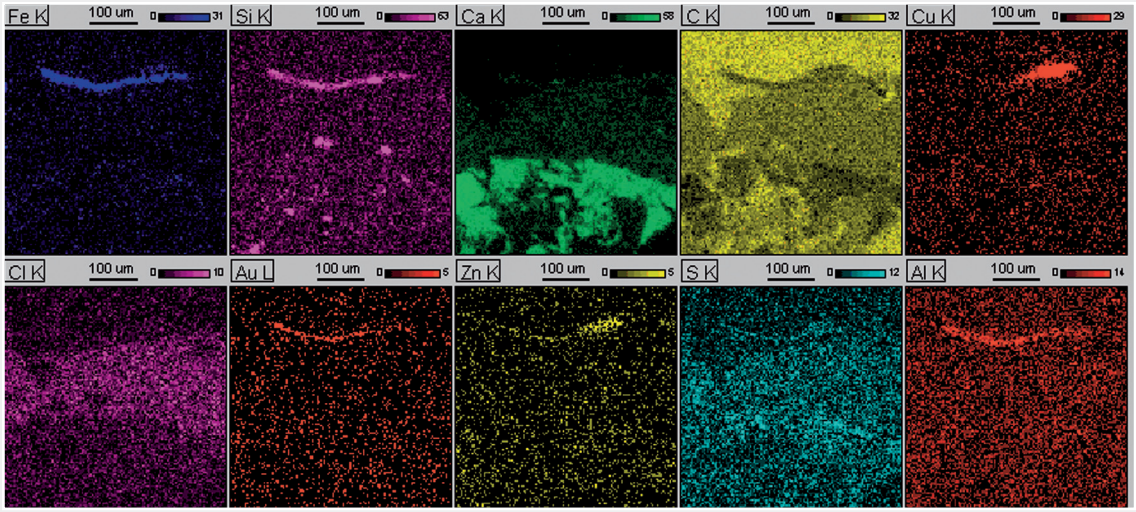
- *Further Examples*

Besides the four frames discussed so far we found four more frames with a similar stratigraphy, and one that was different from all the others.

A large, almost square frame in Museum Boymans Van Beuningen, Rotterdam (inv. nr. Div. M76-KNV) is delicately carved out of lime wood. The rich ornamentation, with allegorical figures, flowers, ribbons, implements of tailors and the like, seems influenced by the sculptor Artus Quellinus[27], while the base of the design and the corners are auricular (fig.15). Large areas of the original gilding on this fine auricular frame are still intact, and provide the best surviving example of its kind. The build-up of layers looks quite similar to the examples at the Rijksmuseum.[28]
The original framing of Gerard ter Borch's *Group Portrait of the Town Council of Deventer*, dated 1667, which is still in the Town Hall in Deventer. The very finely carved frame with festoons, trailing plants and symbols of civil government (relating directly to the subject of the painting) on the auricular carving, is ascribed to the sculptor Derck Daniels (1632-1710). Although this frame has been stripped and re-gilded, in certain undercut areas there are traces of the original finish which look like a priming of thick glue.

A horizontal frame with coats of arms and auricular ornament in Museum de Lakenhal, Leiden (inv. nr. 457) still holds its original painting *The Regents of the Catharina Gasthuis in Leiden* by J. de Vos, dated 1659. Although this lime wood frame shows gilding of a more recent date, the first gilding is still underneath. Cross sections taken from this frame also show a thick transparent layer on top of the wood, but the opaque emulsion layer seems absent here: the gold leaf rests directly on top of the transparent layer.

A series of large paintings by Willem van de Velde the Elder, depicting naval battles at the Rijksmuseum are still in their original frames. Mounted on these ebony profile frames are cartouches carved out of lime wood, combining auricular design, trophy motifs and shields with information about the paintings. It is hard to tell if these cartouches were originally gilded, because they have undergone rigorous treatments against woodworm, but they clearly give the impression of the familiar priming with thick glue.
A horizontal frame in the Rijksmuseum (BK-1974-153) made of carved walnut with auricular ornament, flower garlands, birds, tassels and putties has been overgilded, but there are places where the original finish can be seen, which again seems to consist of a thick layer of glue covered by a much thinner emulsion paint to adhere the gold.
Finally, there is an ornate vertical frame at the Rijksmuseum (SK-L-1804,) in the later auricular style.[29] The original layers on this frame are presently buried under silver leaf and covered with gold-coloured varnish ('mecca'), bronze paint, and aluminium paint. Original matte gilding underneath these layers is still there, not on top of a transparent primer, but on a *black* ground. This frame is the only one of investigated objects which does not have a transparent layer directly on the wood, but instead a layer pigmented with lampblack.[30] On top of the black layer is a much thinner unpigmented oily layer, which shows up clearly in some cross sections. Staining tests showed the presence of unsaturated fatty acids in this layer which may indicate an oil gilding.[31]



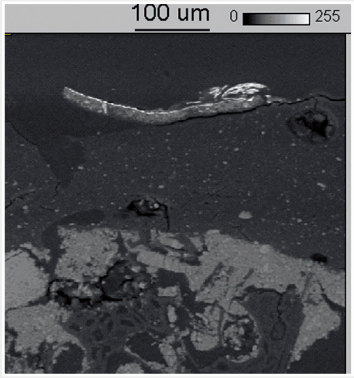


Fig.13b Frame SK-L-4008, Rijksmuseum Amsterdam (see Fig. 9). Distribution of elements in cross section, sample No. 108-3.

Fig.13a Frame SK-L-4008, Rijksmuseum Amsterdam. Image with Scanning Electron Microscope in crosssection, sample No. 108-3.

Fig.14 Frame SK-L-4008, Rijksmuseum Amsterdam. Cross section, sample No. 108-3, with results of staining for proteins with fluorescein isothiocyanate (FITC) and acid Fuchsine, and for fatty acids with 2,7-dichlorofluorescein (DCF) and Rhodamin-B

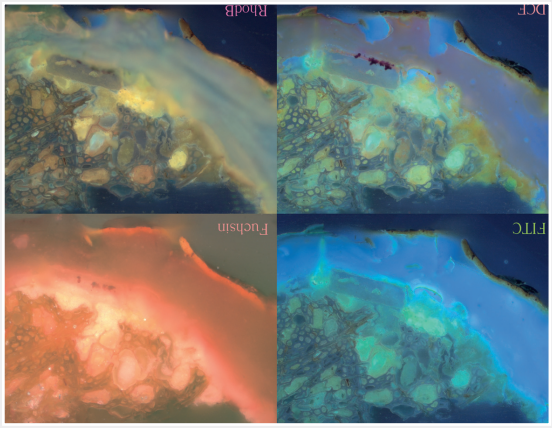


Fig.15 Detail of a large frame, Boijmans-Van Beuningen Museum, Rotterdam, Inv. No. M76-KNV, providing one of the best preserved examples of the original gilding on an auricular frame. Photo Camille Marchand

Conclusion

The gilding on nine frames in the Dutch auricular style (1640s – 1660s) has been investigated. Eight of these frames show a remarkable similarity build-up of layers. During the 1640s, 1650s and 1660s it seems that a gilding technique was practiced whereby substantial layers consisting primarily of animal glue were used directly on the wood, instead of traditional chalk ground or gesso. Perhaps fashion called for a particular visual effect, but more likely the invention increased the speed of production in an active art market, and saved labour costs. Thick glue priming is a faster and easier way to produce a smooth surface over the grain of the wood than chalk ground, which requires not only careful application, but also sanding.[32] A thin layer of pigmented emulsion paint on top served both as a coloured ground and as a size for the gold leaf. There also are indications that the gilding may have been toned with a varnish but no traces of colorant were detected in such varnish. Although this technique probably once produced beautiful gilded surfaces, it proved unstable in uncontrolled environments because of considerable shrinking and swelling of the thick glue layer, combined with dimensional changes of the wood. The gilding on some pieces may have deteriorated within decades of production.[33] This has led to early overgilding on nearly all known surviving examples.

There may also have been other reasons for the Dutch to stop using this technique during the second half of the century. Perhaps water gilding was introduced following the lifting of the Edict of Nantes (1685), causing many Huguenots to leave France. They may have reintroduced the custom of carving in oak and water gilding on red bole. The activities in the Dutch Republic of the influential French designer Daniel Marot, are associated with this development. Indeed, from around 1690 – coinciding with Marot's activities in the Dutch Republic – French style frames carved out of oak, and finished with water gilding on red bole have increasingly been produced in Holland.[34]

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Notes

1 See works for example by Emmanuel de Witte (c.1616-1691), Jan Steen (1626-1679), Pieter de Hooch (1629-1684), Gabriël Metsu (1629-1667), Johannes Vermeer (1632-1675) and Michiel van Musscher (1645-1705). Gerard ter Borch (1617-1681). P.J.J. van Thiel, C.J de Bruyn Kops, J. Cleveringa, W. Kloek and A. Vels Heijn, *All the Paintings of the Rijksmuseum in Amsterdam*, (Amsterdam, 1976). H. Chapman, W. Kloek and A. Wheelock, *Jan Steen, Painter and Story Teller*, (Amsterdam, Washington, 1996). J. Kiers and F. Tissink, *The Glory of the Golden Age*, (Amsterdam, 2000).

2 J.R. ter Molen, *Een Utrechtse familie van zilversmeden met een internationale faam*, (Leiderdorp, 1984) , M.I.E. van Zijl and J.R. ter Molen, *Zeldzaam zilver uit de gouden eeuw: de Utrechtse edelsmeden Van Vianen*, (Utrecht, 1984).

3 Kiers and Tissink 2000, 16.

4 *Framing in the Golden Age* by P.J.J. van Thiel and C. J. de Bruyn Kops was published in English in 1995. It was first published in Dutch as a catalogue for the exhibition Prijst de Lijst, De Hollandse schilderijlijst in de zeventiende eeuw, (The Hague, 1984). The exhibition featured ninety-eight seventeenth-century Dutch paintings, all with their original frames, and extensive catalogue entries provide technical and art historical information about each painting and its framing.

5 Northern European priming was usually made with calcium carbonate and called 'chalk ground'. Artworks from the Mediterranean countries tend to have a priming based on (slaked or burnt) calcium sulfate (gypsum), commonly known as gesso.

6 Unpublished report 1995, Getty Conservation Institute. Personal communication 2004, A. Wallert, curator, Rijksmuseum Amsterdam.

7 For a detailed discussion see, A.M. von Graevenitz, *Das niederländische Ohrmuschel-Ornament, Phänomen und Entwicklung dargestellt an den Werken und Entwurfen der Goldschmiedefamilien Vianen und Lutma*, (Bamberg/Amsterdam, 1973).

8 See for example a gilt wood side table, c.1660, in the auricular style at the Centraal Museum in Utrecht (personal communication 2004 by D.J. Biemond, curator, Rijksmuseum Amsterdam).

9 The frames are in use at the Rijksmuseum for flower still lifes by Jan de Heem (SK-A-138) and Abraham Mignon (SK-A-268) respectively, but are not the original frames for these paintings.

10 Spectra were taken with a Perkin Elmer Spectrum 1000 Auto Image FTIR microscope, with the use of a diamond compression cell. Unpublished report by Suzan de Groot, ICN (1994.) The combination of peaks at 1630 and 1542 cm^{-1}, was taken as indication for the presence of proteinaceous material. Absorptions at 1700 and 1774 cm^{-1}, may refer to the presence of natural varnish resins. See also note 21.

11 Polarized light microscopy (PLM) of pigment dispersions in transmitted light was done with the Leitz Orthoplan polarizing microscope for the identification of inorganic pigments. Objective magnifications ranged from 100x; 200x; to 500x. Yellow ochre was identified with PLM as isotropic particles with $n > 1.66$. The presence of Fe was identified with microchemical analysis (MCA) (development of red colour with NH_4CNS reagent). Lead white in the mixture was identified with PLM, showing milky white highly birefringent plate-like particles with very high refractive indices ($n >> 1.66$) MCA was used to confirm this identification of a lead carbonate: carbonate effervescence in acid, Pb reaction with KI-solution.

12 Thin layer chromatography (TLC) was done on Merck HPTLC 60 F_{254} silica plates with a benzene: methanol (95 : 5) eluent. Plates are developed three times over a total time of approximately 45 minutes. Spots were detected in ambient light and UV light, before and after spraying and heating (100°C for 10 minutes) with an antimony trichloride reagent. The spots of the unknown matched with the reference of mastic resin. Procedure according to E. Stahl, *Dünnschicht-Chromatographie, Ein Laboratoriumshandbuch*, (Berlin, 1962), 213-215. GCMS showed saturated and unsaturated fatty acids.

13 Staining of cross sections with Amido Black AB 2 for proteins and Sudan Black for oils had been done in 1994 in the ICN (then Central Laboratory), Amsterdam. Since then procedures have evolved, and staining tests on the same cross sections were performed in 1998 at the Rijksmuseum. For the detection of proteins Fluorescine isothyocyanate (FITC) and acid Fuchsine was used. Lipids were stained with 2,7-dichlorofluorescein (DCF) and with Rhodamine B. For staining techniques see: S. Schaefer, 'Fluorescent staining techniques for the characterization of binding media within paint cross sections and digital image processing for the quantification of staining results', T. Bakkenist, R. Hoppenbrouwers, H. Dubois eds., *Early Italian Paintings; Techniques and Analysis*, Symposium proceedings, Maastricht 9-10 October 1996, 57-64.

14 FTIR spectrometry indicated a weak presence of resin. With TLC this resin was identified as mastic. See notes 10 and 11.

15 Polarized light microscopy (PLM) of pigment dispersions in transmitted light was done with the Leitz Orthoplan microscope. The white pigment of the first ground layer showed as extremely bi-refringent rhombohedra with parallel extinction. The refractive indices were slightly lower than that of our standard mounting medium (Cargille melt mount $N = 1.662$). It was not possible to give an exact figure for variations in $N\omega$. The microscopy gave a perfect match with our laboratory standard for calcite.

16 Scanning electron microscope (SEM) examinations with energy dispersive spectrometry of x-rays (EDX) were performed on a JEOL JXA-840A electronprobe micro analyzer, usually at 10nA., 25kV, with a 39mm working distance. Samples were either examined in the 'low-vacuum-mode', or coated with a thin carbon coating to improve the conductivity of the sample and so prevent the accumulation of charge. EDX analyses were performed at various points throughout the cross section by measuring the emitted X-rays with a Noran Vantage EDS-system with Pioneer Norvar detector.SEM/IDS.

17 Calcite, or calcium carbonate, is also called 'chalk'. Polarised light microscopy gave the first identification of calcite. This was confirmed by X-ray diffraction (XRD) analyses (in 57.3 mm Gandolfi cameras with CuKα radiation, voltage set at 40kV, with current at 30mA, exposure times 0:50 to 1:30 hours) The patterns showed good correspondence with PDF files 5-453 for calcium carbonate (aragonite) and with some lines of 13-131 for lead carbonate hydroxide (hydrocerussite).

18 Fluorescein iso-thiocyanate (FITC) in ethanol. See note 13.

19 Staining tests for lipids were performed with 2.7-dichlorofluorescein and Rhodamine B. See note 13.

20 B. Skans, P. Michelsen, 'Die Bedeutung von Fett in Tierleim für Malzwecke', *Maltechnik / Restauro*, 2/92 (1986), 63-71.

21 The analysis was done on a Perkin Elmer Spectrum 1000 instrument with use of the Golden Gate, Single Reflection Diamond ATR method (by S. de Groot of ICN, 8.X.2003). The specific absorptions at 1650 and 1540 cm^{-1}, for amide bands I and II, as well as absorptions at 3305, 2927, and 1405 cm^{-1}, gave clear indication that the sample consisted almost entirely of proteinaceous material. The slight absorptions at 2514 – 1797 – 1433 – 875 – 714 cm^{-1} in the spectrum refer to those of calcium carbonate, and are due to remnants of the chalk that was rubbed into the wood cells as the first layer.

22 GCMS analyses (by H. van Keulen of ICN 9.X.2003) of ECF-amino acid derivatives SPB50 140-280-3 with norleucine as internal standard. (MS method: ecfsir 2; GC method: ecf)

23 Analysis was done with the TMAH-Py-GCMS method (by H. van Keulen of ICN on 1.VII.2004), with the addition of 2.5% of TMAH reagent. Oven at 625°C, using a 15 meter DB5, 0.25 diameter column with temperature range of 40 – 310°C (MS and GC methods: tmahfas).
24 Future analysis with antibody staining may show from which animal(s) the glue was extracted and tell us more about the workshop practice.
25 Experiments by the author, the Rijksmuseum Amsterdam.
26 Bronze paint, or 'gold paint' contains tiny particles of an alloy consisting of copper and zinc (brass).
27 Verbal communication with F. Scholten, curator, Rijksmuseum Amsterdam. See note 28.
28 Camille Marchand conserved this frame at the Boijmans Van Beuningen Museum in the 1990s by softening the existing glue priming with a small steam pistol and laying it flat on the wood, using spatula's and melinex film. No additional adhesive was required.
29 This frame was purchased in 1987 in Switzerland and probably dates from the late 1660s. E. F. Koldeweij, art historian, Netherlands State Service for the Conservation of Monuments and Historic Buildings and Sites, noted that the exact design for the vertical members of the Rijksmuseum frame (except for the auricular background) is depicted in *Vande voornaemste statuen ende citaten, vant konstrijck Stadthuys van Amstelredam, tmeeste in marmer gemaeckt door Artus Quellinus*, a book with etchings by Hubertus Quellinus after the sculptures by his brother Artus Quellinus from the Amsterdam City Hall, now Royal Palace. This book was first published in 1655, but has been reprinted several times and was known throughout Europe. The original sculpture, which served as the example, consists of two reliefs of white marble that still can be found in the palace today.
30 This black layer appears to be a regular oil paint. Direct temperature resolved mass spectrometry (DTMS) measurements were done on a very small sample of this black material with a JEOL SX102A double focusing mass spectrometer with a B/E geometry. The sample was homogenised in ethanol and placed on a Pt/Rh (9:1) wire, which was resistively heated (05A/min). The temperature was increased in 2 minutes from room temperature to approximately 800 C. Desorbed material was ionised by 16eV electron impact ionisation, with the mass spectrometer scanning each second over a m/z 20-1000 range. Total acquisition time for each measurement was 2 minutes. DTMS gave peaks for fatty acids such as palmitic acid C16 (m/z 256, with m/z 239 for the esters), or stearic acid C18 (m/z 284 with M/z 267 for the esters), C20 (m/z 312), and C22 (m/z 340) which is consistent with a regular drying oil.
31 Staining with 2.7' dichlorofluorescine and Rhodamine-B.
32 Although in the cross sections taken from auricular frames no separate strata could be distinguished, studio experiments (see note 25) show that it takes at least four layers of concentrated rabbit skin glue on lime wood carving to create a glossy, glass-like transparent appearance similar to the researched frames. An emulsion of rabbit skin glue and approximately ten percent raw linseed oil can be applied in thicker layers, allowing for only two or three layers to reach a smooth surface. This emulsion does not dry to a transparent, glossy layer like the glue, but to a translucent 'egg shell' finish.
33 Wood remains responsive to changes in relative humidity of the environment. Moreover animal glue is a hygroscopic substance and is therefore also quite reactive to humidity changes.
34 Examples of such frames are documented in *Framing in the Golden Age*, cat. nos. 91 and 94.