A BRIEF BACKGROUND TO RENAISSANCE FRAMES

The widespread demand for both religious and secular images during the fifteenth and sixteenth centuries resulted in a growing market for frames to house them. Painted or sculpted images of Christ, the Virgin and saints adorned every altar, and both traditional and new forms of altarpiece required framing solutions. Christian imagery was also not just confined to the church, but was found in a variety of public and more intimate settings. For example the small relief with Eve on the base, that was originally part of a triptych Frame 9 (6867-1860), probably belonged to a woman who would have used it in her devotional practice at home or perhaps when travelling. In addition to prompting devotion, such images often carried talismanic associations. In fifteenth century Florence, for instance, Fra Dominici suggested that an image of the Virgin and Child should be kept in every bedchamber as an example. Virgin and Childs were also set up on street corners as neighbourhood protectors.[1]

These Madonnas often took the form of sculptural reliefs made of terracotta (fired clay) or stucco (a type plaster), which were then painted and gilded to create colourful and naturalistic images see Frame 4 (57:2-1867) and 7 (93-1882). One of the advantages of these materials, which were cheaper than stone or marble, was their malleability, allowing them to be cast in moulds to produce replicas of the same scene. Although little is known about workshop practice, it is clear that such reliefs were reproduced widely: a vast number of Virgin and Childs survive, testifying to their popularity and significance. Five frames in this volume still contain what appear to be their original sculptures.

Tabernacle frames were used to house many of these religious subjects. Sansovino, tondo and cassetta frames were also used in this way, but equally housed secular images, such as the portraits and mythological scenes that increasingly decorated public buildings and the homes of the nobility and growing merchant classes.

Although many of these sculptures or pictures and their frames were commissioned, Renaissance artists also produced a stock of uncommissioned works to sell.[2] It is also possible that they kept a supply of the separate elements needed to make the frames, such as lengths of uncarved mouldings and a selection of moulds for ornamental cast work.

Research has suggested a close relationship between painters and wood workers.[3] They were employed to produce or decorate a range of images and objects, from altarpieces and portraits to candlesticks and furniture.[4] Thus comparisons can be drawn between the materials, techniques and practice used in the fabrication of altarpieces, panel paintings, furniture and related objects of the time and those used on frames.[5]

References

1. Currie, S. & Motture, P. *The Sculpted Object 1400-1700*. Aldershot: Scholar Press, 1997. pp. 1–24.
2. Dunkerton, J., Foister, S., Gordon, D. & Penny, N. *Giotto to Dürer: Early Renaissance Painting in the National Gallery*. London: National Gallery, 1991. p. 128.
3. Gilbert, C. Peintres et menuisiers au debut de la Renaissance en Italie. *Revue de l'Art*, 37, 1977. pp. 9–28; Newbery, T., Bisacca, G. & Kanter, L. *Italian Renaissance Frames Exhibition Catalogue*. New York: Metropolitan Museum, 1990. Dunkerton et al., op cit. pp. 122–141.
4. Dunkerton et al., ibid. p. 122.
5. Thanks to Peta Motture for her valuable contributed to this section.

WOOD

Definitive identification of wood usually requires microscopic identification of anatomical features and typically requires a cubic centimetre of sample to be removed from the object.[1] Such interventive sampling was considered inappropriate for this project, particularly for the smaller frames. Identification of the hardwoods listed in the frame entries was therefore based on visual examination of gross anatomical characteristics.[2] Accretions or coatings often obscure the characteristics required for identification and limit the accuracy of visual identification. Softwoods, for example pine and spruce, are relatively easy to distinguish from hardwoods but cannot reliably be distinguished from each other without microscopic identification. Whereas walnut and oak have distinctive characteristics that are visible to the naked eye, lime and poplar can be difficult to distinguish from each other by eye alone. In some instances, both woods are suggested in the frame entry, with the most probable wood listed first.

Woods used by Italian Renaissance frame makers and craftsmen are discussed elsewhere.[3] Mitchell suggested that the identification of species of wood used in frames can, as for furniture, be an important guide to a likely region of origin. Analysis of woods in seventy Italian frames in a 1976 exhibition suggested that Venetian frames were generally made of pine or fir with fir backs. Florentine frames generally had walnut for carved mouldings, as well as poplar and lime, with poplar or pine back frames, whereas in Bologna and Naples poplar was normally used.[4] Woods found on the V&A frames include the following softwoods and hardwoods.

Softwoods

Found on the back of several frames, softwoods have distinctive early and late-season growth rings that produce alternating soft pale and harder dark stripes in the wood.

Hardwoods

Poplar (*Populus* spp.) is a creamy white to pale brown, medium-density and comparatively lightweight timber. It is straight grained with a fine uniform texture. Poplar was an abundant, relatively cheap wood in Italy. Its texture made it a suitable substrate for painted and gilded decoration. White poplar (*Populus alba*), which grew to a size from which large planks could be obtained, was the wood most commonly used for panel paintings.[5] Poplar was observed on many of the frames and was used for structural work, simple mouldings or carving.

European lime *(Tilia* spp., principally *T. vulgaris*) is a pale yellow wood that turns light brown on exposure to light. It is soft and has a fine uniform texture that makes it an excellent wood for carving detailed and delicate work. Lime was observed on the more intricately carved parts and front mouldings on some of the frames.

European walnut (*Juglans regia*) is a chocolate to grey–pink brown medium-density timber, in which dark streaks and patches are often observed. The sapwood is pale in contrast to the heartwood, which fades when exposed to sunlight. Walnut has visible growth rings and a medium texture. Italian walnut is paler than English. Walnut was valued for its rich colour and was generally used where its appearance could be seen and appreciated. It is good for carving and was often partially gilded, as seen on Frames 20 (7694-1861) and 23 (682-1883).

Fruit woods, such as pear or plum, were sometimes substituted for walnut, either because their particular colour and texture were preferred or simply because they were more readily available.[6]

Pear (*Pyrus communis*) is typically a pinkish-brown colour with a straight grain and a fine, even texture. Pear was thought to have been used for the finer detailed carving on Frame 10 (1079–1884).

European oak (*Quercus robur, Q. pedunculata, Q. petraea, Q. sessiliflora*) is yellowish-brown, with light coloured sapwood. It darkens with age. It is generally straight grained but varies with growth conditions. It has a characteristic coarse grain, and distinct growth rings with alternating zones of open-pored early wood and dense late wood. Distinctive broad silvery rays are present in quarter-sawn material. Oak is very rarely encountered in Italian frames. The two frames made of oak are thought to be French (Frame 12, 649-1890) and Flemish (Frame 27, 1605-1855), partly for this reason.

Tools

Renaissance craftsmen had an extensive range of woodworking tools, similar to those found in specialist carving, framing or cabinet-making workshops today. Olga and Wilmering provide a detailed account of woodworking tools used in Renaissance Italy.[7]

Wood Finishes

Oils, varnishes and stains were in use in the sixteenth century to adjust tone, to enhance colour or to give a shiny or matt finish to wood. Juniper resin, walnut and linseed oil have been mentioned as ingredients for varnishes.[8] Original wood finishes can be difficult to distinguish from varnishes and waxes applied during later repairs and restorations.

Wood had been left deliberately exposed on Frames 20 (7694-1861) and 23 (682-1883), which are sixteenth century partially gilt walnut. A stain, wax or varnish may have been applied to enhance the colour of the wood on these frames.

References

1. Hoadley, B. *Identifying wood*. Newtown, CT: Taunton Press, 1990.
2. Thanks to Dick Onians and Dr Adam Bowett.
3. Olga, R. and Wilmering, A. *The Gubbio Studiolo and its conservation*. New York: Metropolitan Museum of Art, 2001. pp. 3–26; Mitchell, P. Italian picture frames, 1500–1825: a brief survey. *Journal of the Furniture History Society*, 20, 1984. p. 20; Bomford, D., Dunkerton, J., Gordon, D. and Roy, A. *Art in the making: Italian painting before 1400*. Exhibition Catalogue. London: National Gallery, 1992. pp. 11–13.
4. Mitchell, P. Italian picture frames, 1500–1825: a brief survey. *Journal of the Furniture History Society*, 20, 1984. p. 20.
5. Dunkerton, J., Foister, S., Gordon, D. and Penny, N. *Giotto to Dürer: early Renaissance painting in the National Gallery*. London: National Gallery, 1991. p. 152.
6. Newbery, T., Bisacca, G. and Kanter, L. *Italian Renaissance frames*. Exhibition Catalogue. New York: Metropolitan Museum, 1990. p. 28.
7. See Olga, R. and Wilmering, A. *The Gubbio Studiolo and its conservation*. New York: Metropolitan Museum of Art, 2001. pp. 43–59. This section is rich with illustrations of tools and their use.
8. Ibid. pp. 40–42.

METHODS OF CONSTRUCTION

Most Italian tabernacle, Sansovino and cassetta frames were made of a joined back frame that formed a rigid structure onto which the decorative elements, for convenience called the front frame, were applied. The back frame usually consisted of four wooden members, two vertical sides and a horizontal top and bottom. The wood used for the back frames was smoothed flat, although not highly finished. The back frames utilised simple joints such as the corner bridle or T-bridle joint, which were sometimes pegged through (*cavicchio*). Alternatively, a lap or halved joint (*mezza pialla*) was used.[1] The keyed dovetail half lap was also found. Larger parts of the decorative fronts of the frames were usually butted up to each other and fixed on to the back frame with glue and nails. Butt mitre joints were used for the corners of the sight mouldings.

Mouldings

The sight edge mouldings, whether integral or applied, were mitred at the corners. Other running mouldings, for example the cornice moulding applied to an entablature, were shaped in lengths, cut to size, mitred to fit the frame and then fixed with glue and nails.

The profiles of the moulding most commonly found on the frames were:

- Astragal: a small semicircular moulding, sometimes ornamented by bead or reel
- Cavetto: a concave moulding of more or less quarter round profile
- Cyma recta, or ogee: a moulding of S-shaped profile, concave over convex
- Cyma reversa, or reverse ogee: a moulding of S-shaped profile, convex over concave
- Fillet: a small, flat component, rectangular in section, separating one moulding from another
- Ovolo: a convex elliptical or quarter round moulding
- Quirk: a small channel or recess between mouldings
- Torus: a large convex moulding, sometimes called a round, generally used in column bases.

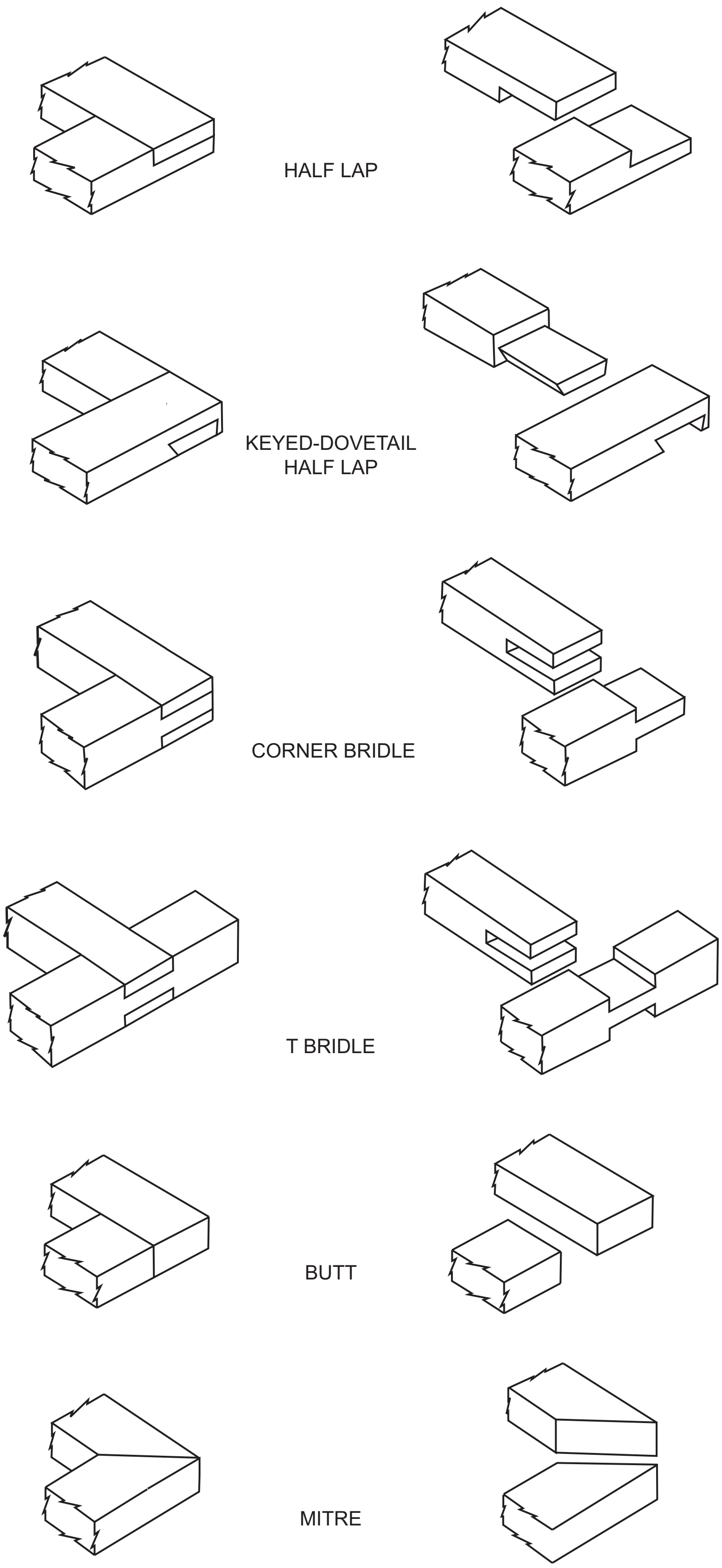
Tabernacle Frames

In most cases, regardless of size, the front frames of the tabernacle frames were constructed following architectural models, with separate parts for pediment, entablature, capitals, columns or pilasters, plinth and predella. Imposts and pedestals were often made from additional pieces of wood with vertical grain, as opposed to the horizontal grain direction of the main parts of the entablature and predella to which they were fixed. Running mouldings, and the frieze relief could be integral or applied and were often mitred at the corners. In contrast to this model, Frame 11 (7820-1861) utilised half lap joints and did not have a back frame.

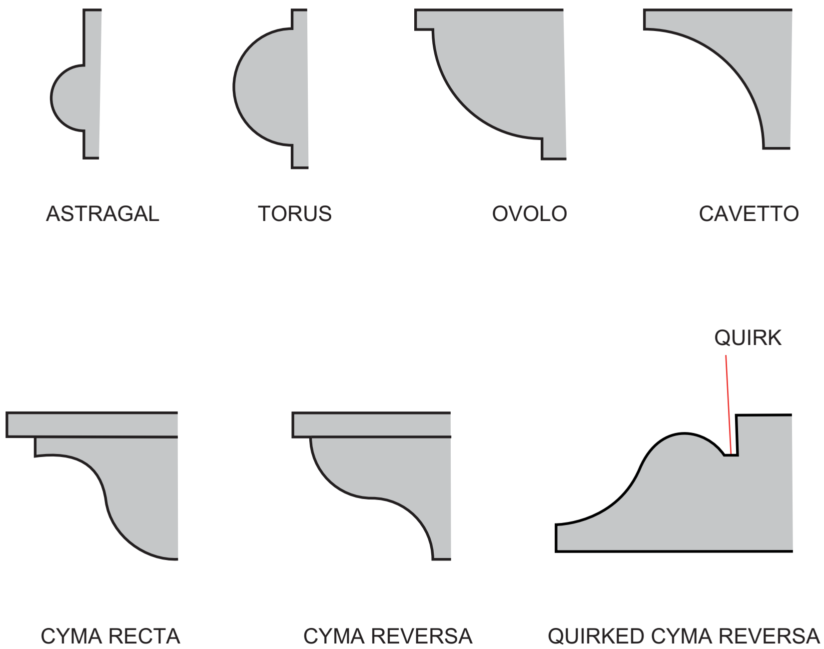
Sansovino Frames

The front frames of the Sansovino frames were generally made up of four main pieces. Like the tabernacle frames from which they were loosely architecturally and structurally derived, the sides were butted between the top and bottom pieces, relying on the joined back frame to which they were attached for stability. The corner-mitred sight edge moulding was integral or applied.

Most of the Sansovino and tabernacle frames used a single depth of wood for the main parts of the carved front frame. Where this was not the case, additional wood was added to create a thicker dimension. Smaller pieces of wood were often



Some joints found on Renaissance frames.



Some mouldings found on the V&A Renaissance frames.

added (nailed and probably glued) to give extra height or width for the carved work or for the higher relief parts of the carving, for example protruding masks or festoons.

Cassetta Frames

These utilised half lapped back frames with mouldings added at the front and sides. The more richly carved examples had additional frieze, decorative corners and centres inset or applied.

Tondo Frames

The large tondo frame 14 (76-1892) was made from several pieces that appeared to have been butt jointed. Mouldings were added at the front and sides, with additional wood for the carved frieze and paterae. The small tondo frames 19 (10-1890) and 20 (7694-1861) were turned on a lathe, and were decorated with carved or pastiglia ornament. Of the two round mirror frames, one had stucco applied on to a wooden frame (Frame 18, 5887-1859) and the other was made from carta pesta (Frame 17, 850-1884).

Reference

1. Joyce, E. *The technique of furniture making*. London: B.T. Batsford, 1987. pp. 158–159.

CARVING (INTAGLIO)

Carving the Parts

Running mouldings were often enriched with carving, such as egg and dart or other repeating ornament. The positioning of the ornament was tailored to fit the lengths used so that one element of the carved ornament completed the design. At a corner mitre, for example, the sculptural surface was continuous, with one element of the running ornament, such as an egg or a dentil, with the join through its centre. Alternatively, a separate motif was carved on each end of the length of the running moulding to complete the design at the corner. However, on entablature and predella it is quite common to see the frieze decoration end in the middle of a decorative element.

Order of Carving and Assembly

It is probable that in most cases, the components of the front frames of tabernacle and Sansovino frames were carved before being fixed to the back frame. This can be deduced by examining the carved festoons on the Sansovino frames. On Frame 24 (765:2-1865), gaining access to carve the underside of the festoons would have been very difficult once they were assembled. Finishing touches were added once the parts had been fixed to the back frame. Occasionally, evidence suggests a different approach. The continuity of the surface between the two pieces of wood forming the hippocampus and leaf detail on the restello frame (21, 7150-1860), for example, suggests that these were carved after assembly.

Frieze decoration, such as scrolling leaves, was generally carved together with the background from one piece of wood. Only on Frames 2 (594-1869) and 33 (4242:1-1857) was the decorative relief carved separately and then applied on to the flat background. In this process, it is likely that a thin piece of wood was glued or nailed to paper on a piece of sacrificial wood and then carved. The carved relief was then removed and applied to the flat background of the frame.

Generally the carving on the frames was well finished, though not crisp, even for pieces that were painted and gilded. The carving on most of the frames displays a bold yet soft fluidity, undulating and unconstrained. The carving on sophisticated examples, such as cassetta Frame 13 (7816-1862), is fine in execution and intricacy, yet retains fluidity and confidence, the product of experienced craftsmen. Carving relief decoration was more time consuming and skilful than making simple running mouldings, so increased the cost of an object.

Modern carving tools: wooden mallet and gouges with different profiles.

Glues

Olga and Wilmering refer to the use of casein glue and animal glue in Renaissance Italy.[1] Casein glue was made from cheese and quick lime. It allowed a longer assembly time but tended to discolour the wood. Animal glue was produced from skin, bones and sinew. It was applied hot, gelled quickly, had high tack and did not discolour the wood. There is no clear evidence of the type of glue used on many of the frames. Some exposed joints show glue, but it is not clear whether it was original or had been applied during later repairs.

Wrought Nails

Wrought iron nails (*chiodi*) were often found securing joints on the frames. These nails are faceted along the shank rather than the round or oval shape associated with modern drawn nails. The majority of the nails observed were small (~3 mm) and medium (~5 mm) sized with rectangular heads. Occasionally larger circular facet-headed nails, approximately 10 mm in diameter, were observed. Similar nails have been observed on Italian Renaissance cassoni at the V&A.[2]

On the frames, the nails were commonly driven from the front through into the back frame. Their angular heads are usually concealed under the painting and gilding, but they can be seen where they have come loose or where they have rusted and caused loss of the overlying finish.

Hanging Fittings

Wrought iron crossover hanging loops were found on many of the frames, fixed to the back of the frame with wrought nails. Another common hanging device consisted of two holes drilled diagonally from the back top centre of the back frame and emerging on the top edge. These holes presumably allowed ribbon, cord or perhaps metal fittings to be passed through the frame.

References

1. Olga, R. and Wilmering, A. *The Gubbio Studiolo and its conservation*. New York: Metropolitan Museum of Art, 2001. pp. 38–40.
2. For example cassone 8974–1863, Tuscany, c.1430–1460.

GILDING

Introduction

Gold leaf may be applied using water, oil or mordant gilding. These processes use distinct methods of preparation and application that result in surfaces with differing qualities and appearance. In the case of Italian fifteenth and sixteenth century gilding on wood, water gilding was used for larger areas, while oil gilding was used for specific decorative elements, such as spots or line drawn patterns. Frames were assembled before being painted or gilded. Both the frame and the framed object were often coated with a continuous white ground layer, painted, gilded and given the same punch work decoration.[1] This continuity was observed on Frames 6 (A.45-1926) and 7 (93-1882).

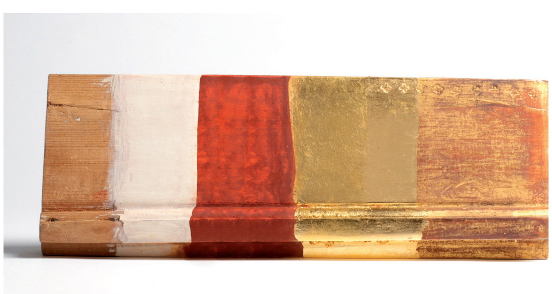
Cennino d'Andrea Cennini's *Il libro dell' arte* (*The craftsman's handbook*), written c.1390, provides invaluable historical insight and informs research into the materials and techniques of early Italian painting and gilding.[2] The workshop inventory of the Sienese painter Neroccio De' Landi (1445–1500) includes a gilder's cushion, several burnishers and other related tools and equipment.[3] These sources provide evidence that gilding tools and processes have changed relatively little since the Renaissance.

Some gilders' materials: 1. Parchment glue size with a hog hair brush. 2. Wet parchment clippings. 3. Dry parchment clippings. 4. Powdered gypsum in glue size and hog hair brush. 5. Powdered gypsum. 6. Powdered yellow ochre in glue size with hog hair brush. 7. Powdered yellow ochre. 8. Red bole in glue size with squirrel hair mop. 9. Powdered Armenian bole. 10. Cone and lump of bole.

Modern gilders' tools: 1. Gilder's tip made from long soft hairs such as squirrel, glued between two pieces of card. 2. Gilder's cushion, with a gold leaf laid flat on the cushion and a gold leaf crumpled at the back of the cushion. In front are leaves of gold in a tissue book. 3. A metal punch and two burnishers made of agate stone, set in metal ferrules on a wooden handles. 4. Gilder's brush or mop, made with soft hair such as squirrel, and gilder's knife, with a smooth fine edge blade, but no sharp edge.

Water Gilding

Water gilding is used to apply gold leaf on to wood. The wood is coated with glue size, followed by a white ground, then bole (often orange–red) to which gold leaf is applied. The gold leaf can then be burnished to a high shine.



Sample of water-gilded wood, showing the preparation layers. Left to right: wood covered with glue size, white ground, red bole, gold leaf, burnished gold leaf, artificially aged gold leaf.

Glue size (*Colle animale*)

Cennini wrote that the glue was made from the neck parts of goat and sheep parchment, which were soaked in water and then boiled. He also described the application of strips of linen soaked in glue size over the joints and knots in the woodwork. It has been suggested that this stage began to be omitted during the fifteenth century.[4] Linen was not observed on any of the frames described in this book.

The ground (*Il gesso*)

The ground was used to fill the wood grain and provide a smooth foundation for subsequent layers. Gypsum and/or chalk were added to warmed animal glue. Clay either could be naturally present in gypsum or chalk or was sometimes added to impart smoothness and hardness to a ground. Pigments, ashes or charcoal could also be added. The warmed mixture was then applied to the sized wood.

Gesso is the Italian name for both gypsum (calcium sulphate) and the white ground found underneath painting and gilding on wood. Gypsum in its raw form is dihydrate of calcium sulphate ($CaSO_4 \cdot 2H_2O$). The white ground may consist of a coarse layer (gesso grosso) followed by a fine layer (gesso sottile), or the fine layer alone.

According to Cennini, gesso grosso was 'coarse plaster of "Volterra" reduced to powder, sifted and then mulled on a slab with the warmed glue size. The gesso grosso was applied to the wood with a knife or bristle brush. Application of a finer ground, gesso sottile, followed'.[5] In his translation of Cennini, Thompson likens coarse plaster of Volterra to plaster of Paris. Mactaggart, however, comments that the use of plaster of Paris grounds has not been supported by analysis and it seems likely that Cennini's gesso grosso was in fact a builder's plaster (anhydrous calcium sulphate, $CaSO_4$).[6]

Gesso sottile was made from coarse plaster that had been soaked ('slaked') in water for several days. The mixture was stirred from time to time to prevent it from setting. After further processing, which is described by Cennini, this was mixed with warm glue. If applied over gesso grosso, the sottile glue mixture was weaker (slightly more dilute) than that used for the underlying layer. If applied on top of gesso grosso, the first coat of sottile could be applied with a hog's hair brush, although Cennini advised the use of fingers. Thereafter it was applied with a hog's hair brush in several coats, each applied while the previous coat was still somewhat damp.[7]

Once fully dry, the white ground could be smoothed with scrapers, metal hooks (*raschietti*) and damp linen rags. Italian Renaissance carved and gilded work is characterised by a general softness about the form, with few hard edges. The sculptural form of Italian frames is largely created in the carved wood, with the white ground softening the form. Although there is generally little obvious carving of the white ground to redefine the form, some more intricately carved examples, such as Frame 14 (76-1892), suggest that carving of the white ground layer may have been used to achieve finer definition.

Gypsum occurs most frequently in the white grounds of paintings and gilding from Italy, Spain and the south of France. Analysis of the grounds of fourteenth century Tuscan panel paintings at the National Gallery identified the presence of both gesso grosso and gesso sottile layers. The grounds of fifteenth century paintings in Florence and Siena tended to consist of the anhydrate form of calcium sulphate (builder's plaster). North of the Apennines, particularly in Venice and Ferrara, the gesso was nearly always of the dihydrate form, suggesting that either gesso sottile or raw gypsum was used.[8] Analysis of the white grounds on the frames in this book identified gypsum, or a mixture of gypsum and chalk.

Chalk (calcium carbonate, $CaCO_3$) has been used in the grounds of paintings and gilded artefacts throughout Europe, including Italy. However, it is more commonly found in northern European countries and is the typical component of the ground layer found in English gilding. 'Gesso' has been adopted as a generic term in English for the white ground for gilding, whether it is made from gypsum, chalk or other materials. To avoid confusion in terminology, the term white ground will be used in this book.

Bole (*Bollo*)

Bole is predominantly made of clay. Its colour can be a result of naturally occurring iron oxides or the deliberate addition of pigments. Colour can range from the yellows, oranges, browns and reds of natural iron oxides, to pink, purple, blue, green, grey, black or white. The colour of the bole affects the tone of the gilding. Gold leaf can look slightly green if laid over white bole, while red bole will impart a warm tone. Gold leaf takes on the texture of the surface to which it is applied, so the choice of a matt (pigment rich) or shiny (clay rich) bole will affect the final appearance. The clay in the bole enables the gold leaf to be burnished.

Bole was applied over the white ground before the application of the gold leaf. The bole was ground in water and the resulting paste mixed with animal glue or glair (whipped egg white left to stand and liquefy, then diluted with water) as the binding medium. The bole could be applied with a soft brush or sponge and once dry, could be polished smooth.

Italian Renaissance frames often have quite a bright orange–red bole. The boles most frequently used on the original gilding on the frames examined in this book were shades of orange, red and red–brown.

Gold leaf (*l'oro*)

Painters were usually contracted to use pure gold. The leaf was manufactured from coinage, for example the gold Florentine florin, that was beaten with hammers, cut, trimmed and beaten again until the required thin leaf was obtained.[9] It is interesting to note that gold beaters were part of the same guild as painters.[10] Cennini discusses how many leaves of gold leaf should be obtained from a ducat (gold coin) for different uses in gilding.[11] Italian Renaissance gold leaf was thicker than that used today. Alloying gold with silver or copper altered the colour of the leaf. Contracts for gilding and painting work sometimes specified that gold alloys, silver or even tin leaf were to be used for minor parts of the painting and the frame.[12] The gold leaf observed on the majority of the frames discussed in this book was of consistently good quality and in some cases, clearly thicker than modern leaf.

Laying gold leaf for water gilding

Before applying the gold leaf, an area of bole was first brushed with water containing a little glair or animal glue size. Cennini instructed that the gold leaf was to be picked up with tweezers, transferred to a sheet of parchment and then slid on to the wetted bole. The water was absorbed into the ground, reactivating the layer of glair or size to which the gold leaf adhered. The next leaf was laid slightly overlapping the previous one. Pieces of cut gold leaf were used to patch minor imperfections in the gilding.

Burnishing (*brunitura*)

Water gilding can be burnished so that the gold surface, in its entirely or in selected areas, takes on a highly reflective shine. Early Italian gilding was extensively and highly burnished. Cennini mentions the use of haematite, sapphires, emeralds, balas rubies, topazes, rubies and garnets or 'teeth from any flesh eating animal' for burnishing.[13] The burnisher needed to be perfectly smooth and was used before the preparation layers below the gold were completely dry.

Punch work (*punzonatura, bulinatura*)

Metal punches were used to indent or punch decoration into the gilded surface. This type of decoration appears on several of the frames, for example the background to the candelabrum decoration on Frame 8 (5893-1859).

Oil or Mordant Gilding

Oil gilding derives its name from the use of an oil-based adhesive. In gilding terminology, mordant refers to any material that has adhesive properties. Cennini referred to the use of varnish, linseed oil with the addition of lead white, or garlic juice with lead white and a little bole.[14] Oil or mordant gilding can be applied to any substrate provided that the surface is non-porous or has been coated to make it non-porous. Mordant gilding can sometimes be recognised by the texture of brush strokes or runs in the mordant.

The oil size or mordant, which could be coloured with pigment, was applied to the area to be gilded. It could be a thin layer or bulked with fillers or pigments to create raised patterns. The gold leaf adhered only to the mordant and thus allowed very fine decoration to be applied to selected areas. Oil gilding usually has an even, matt finish. It should not be assumed, however, that all oil gilding was matt as it could be bright and reflective if the ground prepared for it was smooth and glossy. The longer the drying time of the mordant, the more reflective the finish produced, although the greater the risk that particles of dust would become attached to the mordant and affect the texture of the gilded surface.

Shell gold/powdered gold

Powdered gold can be mixed with a binder such as gum arabic to make a gold paint. The name shell gold derived from the practice of using and storing the paint in shells. Shell gold has a fine granular texture and appears quite dull. It was applied with a brush, usually only for areas of fine decoration.

Partial gilding (*luminolegno*)

While most of the frames described in this book were fully gilded, some, mainly made from walnut, were partially gilded. On these frames, selected ornament was highlighted with water or mordant gilding. Frame 23 (682-1883) utilised both types of gilding. Fine gilded detail was used on Frame 22 (535:A-1870) to create an impression of carved ornament, for example fluting in the cornice.

Coatings

Gilding could be decorated with varnish or transparent coloured finishes. Analysis of some of the frames showed the presence of lakes that may have imparted colour to glazes, for example the red lake on Frame 8 (5893-1859). Gilding could also be coated with transparent materials, such as glair or glue size, to protect the surface or modify its appearance.

References

1. Dunkerton, J., Foister, S., Gordon, D. and Penny, N. *Giotto to Dürer: early Renaissance painting in the National Gallery*. London: National Gallery, 1991. p. 174.
2. Cennini, Cenninod'Andrea *The craftsman's handbook, 'Il libro dell' arte'*. c.1390. Thompson, D. V. (trans.), 1960: Dover Publications. New York; Bomford, D., Dunkerton, J., Gordon, D. and Roy, A. *Art in the making: Italian painting before 1400*. Exhibition Catalogue, London: National Gallery, 1992. Dunkerton et al., ibid.
3. Dunkerton et al., op. cit. p. 141.
4. Dunkerton et al., op. cit. p. 163.
5. Cennini, op. cit. pp. 70–71.
6. Mactaggart, P. and Mactaggart, A. *A pigment microscopists's notebook.* 7th rev. Somerset: unpublished paper by the authors, 1998. p. 43.
7. Cennini, op. cit. pp. 70–73.
8. Dunkerton et al., op. cit. p. 163.
9. Bomford et al., op. cit. p. 22.
10. Dunkerton et al., op. cit. p. 174.
11. Cennini, op. cit. pp. 84–85.
12. Dunkerton et al., op. cit. pp. 131 and 175.
13. Cennini et al., op. cit. p. 82.
14. Cennini et al., op. cit. pp. 96–97.

CAST WORK

Low relief cast ornament, often with intricate designs, was frequently applied to Renaissance objects including caskets, cassone and frames. It had a different character to carved work but was quicker and cheaper to produce. Cast work was left plain or coated with white ground and then painted and/or gilded.

Pastiglia

Pastiglia was made by mixing a powdered bulking material such as chalk, gypsum or lead white with a binder such as animal glue or egg white to make a malleable paste. This was cast in moulds, removed, trimmed as required and then attached to the surface of the object. Analysis of pastiglia found on Frames 10 (1079-1884), 16 (11-1890) and 19 (10-1890) showed that the cast work on all three frames contained similar materials.

The presence of straight cracks crossing the length of the ornament is usually indicative of joins between lengths of applied cast decoration. If joins are found at regular intervals in the design, this can indicate the repeat length of the mould from which the ornament was cast. The lines of the join may not appear perfectly straight, as a result of ageing cracks in the gilded or painted finish, but the lines of such joins should be distinctly straighter than other ageing cracks in the decorative finish or cast work. Joins between the lengths of applied casting can be seen on Frames 16 (11-1890) and 19 (10-1890). These lines help to distinguish pastiglia from aggetti.

The term 'aggetti' has been used to describe the 'low relief designs [that] were made by freehand brush application of a heavy gesso before gilding'.[1] According to Cennini, raised work applied with a brush was made from gesso sottile.[2] The term pastiglia is commonly used to describe aggetti work, although the techniques are very different.

Carta Pesta

Carta pesta, also known as papier mâché, is a general term used to describe crushed paper mixed with glue or glued paper applied in layers in a mould. Frame 17 (850-1884) was made from carta pesta.

Stucco

Stucco describes a slow-setting gypsum plaster mixed with sand, slaked lime and other substances. Different mixtures have different uses. It was used for internal and external decorative architectural work and for sculpture. Frame 18 (5887-1859) incorporates stucco decoration.

References

1. Brettel, R. and Starling, S. *The art of edge: European frames 1300–1900*. Exhibition Catalogue. Chicago, IL: Art Institute of Chicago, 1986. p. 30.
2. Cennini, Cennino d'Andrea, *The craftsman's handbook, 'Il libro dell' arte', c.1390*. Thompson, D. V. (trans.). New York: Dover Publications, 1960. p. 76.

PAINTED DECORATION

Techniques

Decorative paintwork was found on several of the frames. Painted decoration was often used in combination with gilding, in roughly equal proportion. Paint could be applied over the same ground as the gilding, over the bole or over the gilding. This last technique was identified on smaller frames, where the small amount of gold saved by avoiding gilding the areas that were to be painted did not justify the extra time involved.

Although Sansovino frames are commonly gilded or partially gilded against show wood, painted decoration has been found on some Sansovino frames, such as an Italian sixteenth century frame painted green in recessed areas[1] and those with painted cherubs or caryatid figures.[2]

Trompe l'oeil

Trompe l'oeil is a painting technique used to give the impression of three-dimensional decoration, such as carving, on a flat surface. Black paint can be used to indicate recessed areas, with washes of grey skilfully applied to imitate the depth of carved relief. Frames 5 (5768:2-1859) and 11 (7820-1861) were decorated with trompe l'oeil decoration.

Marbling

Marbling describes the painted imitation of the veined or mottled appearance of marble or stone and is common on sixteenth century frames and altarpieces.[3]

Imitation porphyry was observed on the back edge of Frame 3 (19-1891) and possibly on the sloping floor area of Frame 8 (5893-1859).

Sgrafitto (*Il graffito*)

In this technique, paint was applied over burnished water gilding. When this had nearly dried, a softly pointed stylus, made of material such as bone, was used to scrape a decorative pattern through the paint to reveal the gold. Sgrafitto work was seen on Frame 4 (57:2-1867), on the antependium of Frame 3 (19-1891), on the pedestal return of Frame 5 (5768:2-1859) and on the frieze of Frame 9 (6867-1860).

Binding Media

On Renaissance Italian polychrome sculpture and paintings, egg tempera was prepared by grinding pigments in water and then adding about an equal measure of egg yolk. The paint dried to a velvety sheen. Binding media analysis of a sample taken from the sgrafitto work on Frame 9 (6867-1860) identified the presence of an egg-based binder.

Alternatively, pigments ground in water could be mixed with glue size. Although not as common the use of oil as a binder is mentioned by Cennino Cennini[4]

Pigments

The following is a list of pigments in use in the Renaissance that were identified on the frames. These pigments have also been identified on other examples of painted Italian sixteenth century frames.[5]

Azurite (basic carbonate of copper, $2CuCO_3 \cdot Cu(OH)_2$)

Azurite was used in Italy and northern Europe between the fourteenth and seventeenth centuries and was seldom used in Europe after the middle of the seventeenth century. It was the most common blue identified on the frames described in this book. Azurite was an expensive pigment.

Coarsely ground, it produces a bright blue, while finely ground azurite is lighter in tone. The large particle size and consequent low covering power of azurite meant that several layers were necessary to produce a saturated blue when it was applied over a white ground. It was therefore often applied over a coloured underpaint both to enhance the colour and to reduce cost. A coloured layer under azurite was found on several of the frames, including Frame 2 (594-1869). This practice is consistent with the use of azurite on panel paintings and polychrome sculpture.[6]

Carbon black, charcoal, ivory and bone black

Carbon black is known by a variety of names that reflect the traditional method for producing a particular pigment. Charcoal was made by burning wood with a very restricted air supply. Even-grained woods such as beech and willow were used, as well as other organic materials such as peach stones or almond shells. Charcoal could be ground to form carbon black, which was used in oil or watercolour media. Vine prunings were used to produce vine black. Ivory and bone black were made from charred ivory and animal bones.

Earth pigments

Earth pigments have been used since prehistoric times. The iron oxides present in naturally occurring minerals produce a range of yellow, red and brown colours. Pigments found on the frames include yellow ochre (hydrated iron oxide, $Fe_2O_3 \cdot H_2O$, plus a range of mineral impurities) and red ochre (anhydrous ferric oxide, Fe_2O_3, plus a range of mineral impurities), also known as terra rossa. Boles used for gilding were coloured by iron oxide, although the proportion of clay-like minerals exceeded the iron oxide content. Earth pigments are often named after their geographical region of origin.

Indigo

Indigo, a blue pigment, was obtained from a wide range of plants. India and the near East were the main sources of indigo in Renaissance Italy. Indigo was produced from the shrub *Indigofera tinctoria* and imported into Europe in the form of dry cakes. An inferior pigment could be extracted from woad (*Isatis tinctoria*). Indigo was observed in the underlayer for azurite on Frame 3 (19-1891). The use of indigo in the underpaint below azurite is consistent with other works of this period.[7]

Lead white (basic lead (II) carbonate, $2Pb(CO_3)_2 \cdot Pb(OH)_2$)

Lead white has been produced since antiquity by exposing metallic lead to vinegar.

Malachite (basic copper (II) carbonate, $2CuCO_3 \cdot Cu(OH)_2$)

Malachite is a mineral usually associated with azurite. Coarsely ground, it produces a bright green pigment, whereas finely ground, it produces a paler green. Malachite has been in use since Egyptian times. Particles of malachite were found mixed with azurite on some of the frames, for example Frame 3 (19-1891).

Orpiment (arsenic sulfide, As_2S_3)

Orpiment is a naturally occurring yellow mineral prepared as a pigment by grinding or levigation. It is highly toxic owing to the presence of arsenic and has been found on objects and paintings for over 2000 years.

Red lakes

Lakes are dyestuffs precipitated on to a colourless base material with a low refractive index. Lakes are translucent and often used to colour glazes. The natural red dyes that have been used in this manner include madder, kermes, lac, carmine. Red lake was identified on Frame 8 (5893-1859).

Smalt (K Co (Al) silicate (glass))

Smalt was made by roasting a cobalt-containing mineral to form cobalt oxide, CoO, and adding this to molten glass. The glass was ground to form the blue pigment. Smalt has been in use in Europe since the fifteenth century and it has been identified on a number of sixteenth century objects.[8] Smalt was identified in the original blue layer on Frame 8 (5893-1859).

Vermilion (mercuric sulfide, HgS)

Vermilion is found naturally in the form of the mineral cinnabar, the principal ore of mercury. It can be crushed and used directly as a red pigment and has been used since Egyptian times in this manner. The dry process of combining mercury and sulphur to form artificial cinnabar was known by the eighth century AD.

References

1. This frame is pictured in Penny, N. *Frames*. National Gallery Pocket Guides. London: National Gallery, 1997. Plates 56 and 57.
2. See Mitchell, P. and Roberts, L. *Frameworks*. London: Merrell Holberton Publishers, 1996. p. 63; Newbery, T. *Frames in the Robert Lehman Collection.* Princeton, NJ: Metropolitan Museum of Art in association with Princeton University Press, 2007. Plate 32, p. 59.
3. For example, Smith, A., Reeve, A., Powell, C. and Burnstock, A. An altarpiece and its frame: Carlo Crivelli's 'Madonna Della Rondine'. *National Gallery Technical Bulletin,* 13, 1989. p. 28–43.
4. Cennini, cennino d'Andrea. The Craftsman's handbook, 'Il libro dell'arte, c.1390. Thompson, D.V. (trans). New York: Dover Publications, 1960. p. 198.
5. Ravenel, N. Painted Italian picture frames in the Samuel H. Kress Foundation Collection at the National

Some pigments found on the V&A Renaissance frames.
Left to right: Green malachite in raw state and powdered malachite, two lumps of blue azurite with areas of associated green malachite in raw state and powdered azurite, pale powdered blue smalt, dark blue smalt, indigo and bone black.

Gallery of Art. In V. Dorge and F. Carey Howlett, eds. *Painted wood – history and conservation*. Los Angeles: Getty Conservation Institute, 1998. pp. 100–109.

6. Pandolfo, A. Aspetti technici e conservative della scultura lignea policroma. *Kermes*, 1:1, 1988. p. 12, cited by Ravenel, ibid.; Galassi, A. G., Fumagalli, P. and Gritti, E. Conservation and scientific examination of three Northern Italian gilded and painted altarpieces of the sixteenth century. In D. Bigelow, ed. *Gilded wood: conservation and history*. Madison, CT: Sound View Press, 1991. p. 200; Olga, R. and Wilmering, A. *The Gubbio Studiolo and its conservation*. New York: Metropolitan Museum of Art, 2001. p. 169; Smith et al., op. cit.
7. Martin, E. and Bergeon, S. Des bleus profonds chez primitifs Italiens. *Techne*, 4, 1996. pp. 74–89. Smith et al., op. cit.
8. Stege, H. Out of the blue? Considerations on the early use of smalt as blue pigment in European easel painting. *Zeitschrift für Kunsttechnologie und Konservierung*, 18, 2004. pp. 121–142; Spring, M., Higgitt, C. and Saunders, D. Investigation of pigment–medium interaction processes in oil paint containing degraded smalt. *National Gallery Technical Bulletin*, 26. p. 6.

UNDERSTANDING DETERIORATION AND ALTERATION

Many of the tools, materials and techniques utilised for joinery, carving, casting, gilding and painting in the Renaissance have remained in continuous use to the present day. However, there are often differences in execution, materials and ageing characteristics that enable Renaissance work to be distinguished from later work.

In general, nineteenth century makers of reproduction frames did not attempt an exact match of the original materials and techniques. They often employed different methods of construction, mouldings not seen in the Renaissance period, different carving styles and finishes. Marks from tools not available in the Renaissance may also be visible. Present day replica frame makers and their clients have a much more thorough and sophisticated knowledge of Renaissance materials and techniques. As a result, modern replica frames and repairs can be more difficult to recognise.

A key part of the process of understanding Renaissance frames is to interpret changes that have occurred, in order to identify original material and distinguish later additions. It is therefore important to understand the effects of natural ageing and how frames may be altered over the course of time.

Deterioration

Wood

Fluctuations in relative humidity cause wood to expand and contract and can cause glue to fail. When relative humidity is low and the movement of the wood is restrained, for example in cross-grained joints or by fixings, wood may split. Small gaps may appear in joints, for example in corner mitres. High relative humidity is conducive to mould growth and fungal and insect attack.

Damage caused by wood-boring beetles is common in Renaissance frames. The larvae bore within the wood and, if infestation is severe, can create a network of tunnels that weakens the wood. The larvae develop into beetles that bore their way through the surface, creating a flight hole. The extent of damage may not be immediately apparent. Insect-damaged wood is susceptible to breakage and loss, as for example in Frame 21 (7150-1860).

Poor handling and storage can result in dents and breakage. Applied parts can detach, especially if wood movement has loosened fixings.

Decorative surface

Decorative surfaces consist of one or more layers on a substrate. Fluctuations in relative humidity cause the layer(s) and substrate to expand and contract, often at different rates and in different directions. This causes cracking, distortion and separation of finishes from each other and the wood. Gaps in wood joints will cause cracks in the finish. With age, pastiglia decoration can shrink, crack and detach.

Water gilding

In a water-gilded finish, although cracks form both along and across the wood grain, cross-grain cracking is predominant. The animal glue within the preparation layers of the gilded finish expands and contracts equally in all directions in response to fluctuations in relative humidity. The wood expands and contracts across the grain but not along the grain. As a result, the movement of the preparation layers in this direction is restrained by the wood. This incompatibility leads to the formation of cross-grain cracks in the gilded finish.[1] As cracks form, the decorative surface becomes susceptible to flaking. Loss of decorative surface often occurs from the porous end grain of wood.

If wood has shrunk considerably, this may result in the complete separation of the ground layers from the surface of the wood. The resulting shell of painted or gilded finish is very vulnerable to compression damage, for example by handling.

The reflective effects of burnished gilding lessen in time, as a result of fluctuations in relative humidity, handling and accretions of dirt. As water gilding wears, the places where the laid gold leaf had slightly overlapped appear as brighter bands or stripes. As wear continues, the clay bole is revealed, and then the white ground.

Water gilding is particularly susceptible to damage caused by water and abrasion. Inappropriate cleaning can cause much damage, as seen on Frame 9 (6867-1860), where a wet absorbent material has been wiped over the surface, dissolving and smudging the layers.

Mordant gilding

Depending on the mordant, the finish can stay soft for some time after gilding and is easily damaged during the drying period. The mordant can, in time, develop a craquelure and, in turn, the appearance of the gilding becomes more matt.

Silver

Silver leaf tarnishes, eventually completely blackening, as it oxidises owing to the effects of sulphur-based pollutants.

Coatings

Coloured glazes and coatings can fade, darken or become opaque, resulting in loss of subtlety in the original design.

Alteration

Alteration of a frame can occur as a result of repair or replacement of damaged and lost parts, modernisation or change of use.

Wood

Damage and loss of wood due to insect infestation can result in the need to rebuild parts of a frame. If the wood loss was extensive, a reproduction frame may have been made incorporating salvaged parts, for example Frames 29 (163:2-1910) and 33 (4242:1-1857).

In some cases, parts of frames, such as the pediment and antependium, were removed. This could occur if the part was damaged, to modernise the frame, to appeal to a different taste or simply to reduce the overall height to fit into a new setting. Lunettes painted with a religious theme were often removed if the frame was reused for a non-religious painting. Similarly, an antependium might be removed if it had an inappropriate coat of arms for a new owner. In other cases, fragments from several frames may have been incorporated into a new frame. Frame 8 (5893-1859) is thought to have been altered by adding and removing parts to make it fit into a new location.

Change of sight size

Frames were often adapted to fit different objects and such changes might occur more than once. This often required the alteration of the sight size. Wood was added or removed at the corner joints to alter sight size dimensions. Additional mouldings could be used to reduce the sight size and could be set in the rebate. Slip mouldings have a plain or rectangular profile. These project into the aperture of the frame, reducing the sight size dimensions and holding the new, smaller object. Frame 4 (57:2-1867) appears to have had a sight edge moulding added to make the sight size smaller. The frame is thought to be later than the relief, and may have been reused. Another method of reducing the sight size was to cut through the sides of the frame, remove the required length and rejoin the sections.

To make the sight size larger, the sight size moulding could be removed or the frame could be cut through and additional lengths of wood inserted. Sometimes the frame was dismantled, individual parts were cut through at different points and then the whole was reassembled. This made the alterations less obtrusive, as for example on Frame 13 (7816-1862).

Unconventional proportions may betray alterations to the size of a frame. Other clues include misaligned or lost carved corner ornament. The carved ornament on Frame 30 (148-1869), for example, does not meet at the corners of the sight edge.

The presence of straight cut edges through the finish and wood indicates that cuts have been made after gilding was completed. On Frame 10 (1079-1884), for example, the pilaster mouldings have been cut through at the mitres. Close inspection often reveals where carving repairs have been carried out by a different hand, for example the later egg-and-dart carving on Frame 8 (5893-1859).

Examining the back of a frame may reveal later additions that are not apparent from the front, where overpainting or gilding may have been carried out to conceal the alterations. Evidence of structural alterations can include joints that do not relate to original construction or a different colour or type of wood. Sections of wood unaffected by wood-boring beetle in a frame that has suffered attack can indicate later additions. Coatings may have been applied to tone down or obscure such additions.

Later hanging fittings and nails

Non-Renaissance hanging fittings made from cast iron are more regular in shape and have a smoother surface than the original wrought iron hanging loops, which were attached with cut nails. Mirror plates, a common later fitting, are often made of polished brass or chromed.

Cut nails are available today, wrought iron hanging fittings can be reproduced and age can be simulated on both. Modern wrought iron can be identified by chemical analysis of its composition.[2]

Decorative surface

It is common to find alterations to the decorative surface on Renaissance frames carried out to blend in structural repairs to reflect a change in taste. Changes range from retouching small losses to complete overpainting and/or regilding. Careful examination of the decorative finish will often reveal these changes. In fewer cases, the original finish may have been stripped and the object completely repainted and gilded. Occasionally original decoration may survive in good condition. Frame 9 (6867-1860) retains parts of the original gilding on the sight edge moulding under glass that give a good indication of the original appearance of the gilding. On Frame 4 (57:2-1867) original sgrafitto work survives on the inside return of the pedestal.

The more skilful a repair, the more difficult it may be to detect. On Frame 19 (10-1890), repairs have been carried out to areas of gilding and the wooden structure. Although the materials and techniques of the original gilding have been copied faithfully, the repair can be distinguished because the punch work is slightly different.

Retouching of small losses and repairs often overlaps adjacent earlier finishes. In the case of repairs to losses of ground or replacement parts, the thickness, texture or colour of the white ground, bole or gold may differ from the original, as may the method of gilding. An attempt may have been made to blend the repair with the surrounding original surface by rubbing through the gold, the bole, white ground and wood. The natural crack pattern found in a gilded finish may be simulated with a scalpel. Fine scratches may be made in the gold to imitate craquelure, as observed in areas of repair on Frame 14 (76-1892).

Areas of lost or worn finish may be coloured out using paints or stains, including bronze paint, which has also been used to overpaint gilded frames completely. It has a fine grainy appearance and although gold-coloured when first applied, it darkens with age.

Total repainting and regilding may be undertaken because of changes in fashion or to blend in repairs. The decorative scheme may be reinterpreted, fields of colour may be lost and different colours used. Sometimes a darker shade of an original colour may be used, for example on Frame 8 (5893-1859). The original decorative scheme on Frame 26 (771: 2-1865) combined black painted and gilded areas. At some point the whole frame was overgilded, although the original decorative scheme is visible where the later finish is delaminating. An image of this frame has been digitally reconstructed to give an indication of the probable original scheme.

The spandrels on Frame 28 (5633:2-1859) are nineteenth century additions. These were probably added to accommodate the relief it now frames. The spandrels were gilded over a Victoria-plum coloured bole over a brick-red coloured bole. These bole colours are associated with nineteenth century gilding. In order to blend the new and old parts, the nineteenth century scheme was applied over the whole frame.

Overpainting and gilding may soften the sharpness of the original carved sculptural form, as seen on Frame 26 (771:2-1865). The floral detail in the scrolls at the base of each side, for example, is almost completely obscured. Even relatively thin overpainting or gilding can result in loss of detail such as punch work. This has been avoided on Frame 8 (5893-1859) where the front pilaster with earlier gilding has not been overgilded, although other parts have.

In some cases damage to the original surface was not made good before overpainting and gilding. On Frame 22 (535:A-1870), for example, the original surface had shallow craters in areas of loss and the later painting was applied directly over these.

Later coatings

Pigmented coatings are often used to tone in areas of repair, to give the impression of age and natural accretions. These may be applied locally to the repair but often the toning layer extends over adjacent earlier finishes or may be applied all over the frame, front and back. Coatings were commonly made with glue size, linseed oil paint or shellac.

Later varnishes can alter and darken the original colour. The blue background to the female figure on Frame 17 (850-1884), painted with azurite, was once very bright but has dulled to almost black.

Later gilding was sometimes coated with a thin layer of glue size. Dirt can become embedded in this coating over time, resulting in the gilded surface losing its brilliance and becoming dull and opaque, as has occurred on Frame 21 (7150-1860).

The cupping of finishes is often caused by an application of a stronger coat over a weaker one, which causes the weaker finish below to pull away, as seen on Frame 16 (11-1890). Usually this is associated with later coatings or finishes being applied over earlier ones.

References

1. Michalski, S. Crack mechanisms in gilding. In D. Bigelow, ed. *Gilded wood conservation and history*. Madison, CT: Sound View Press, 1980. pp. 171–181.
2. Selwyn, L. *Metals and corrosion: a handbook for the conservation professional*. Ottawa: Canadian Conservation Institute, 2004. pp. 89–112.

SCIENTIFIC ANALYSIS

Scientific analysis is an important tool in the authentication of Renaissance frames. It has been used to add to the body of knowledge of original materials and techniques, and to identify fakes, such as those produced by Icilio Federico Joni (1866–1946) of Siena.

Many of the materials used for painting and gilding today, such as iron oxides, the clays in bole and the chalk and gypsum found in grounds, are indistinguishable from those used in the past. However, many pigments introduced after the Renaissance can be used for dating purposes. The presence of pigments appropriate to a given historical period is not in itself proof of authenticity, as many have remained available through to the present day. Results of scientific analysis must, therefore, be considered in conjunction with an overall examination of the execution, materials and ageing characteristics of the frame.

Analytical Methods

Scientific analysis was used to collect further evidence where later decorative schemes had been identified by visual examination. Although non-destructive methods are preferable, many of the analytical techniques used required the removal of a small sample of material from the frames. A limited number of samples was taken and these were as small as possible.

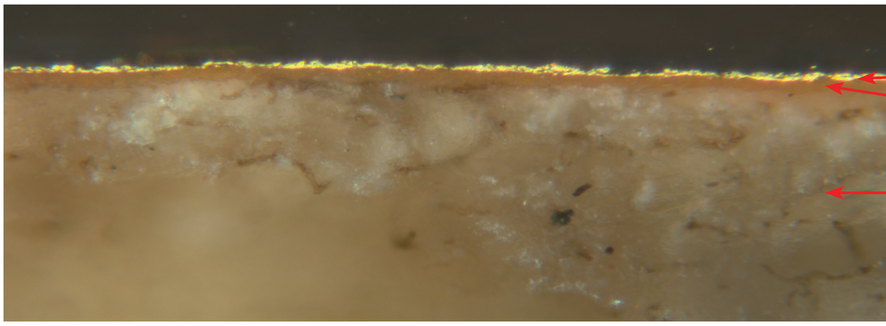
Optical microscopy of samples viewed in cross-section shows the stratigraphy of the layers of paint and gilding, and can be used for pigment identification. Samples can be used to identify later additions where a frame has been overpainted or regilded. On Frame 8 (5893-1859), for example, the original parts of the frame have two decorative schemes whereas later additions have only one.

Samples of the surface decoration, usually including the ground layers, were analysed by the National Gallery Scientific Department. The samples were mounted in polyester embedding resin and ground and polished to reveal the edge of the sample. These were examined in reflected (incident), ultraviolet and polarised light at magnifications up to 500 ×.

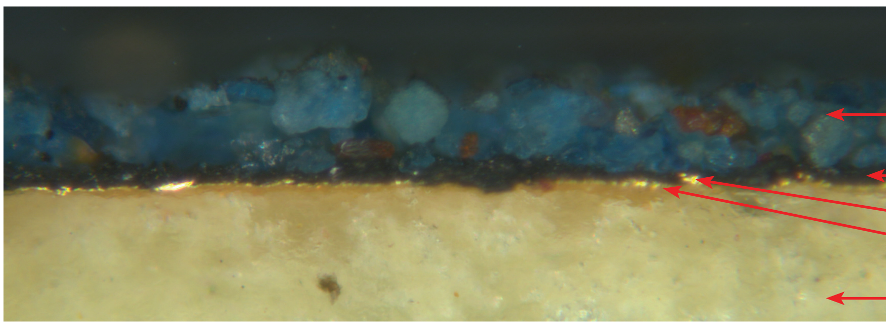
Pigment particles were taken from existing samples, treated with dichloromethane to soften any binding media, crushed between glass slides to separate the particles, mounted on microscope slides with Meltmount 1.66 resin and examined with a Swift polarising microscope by Dr Brian Singer.

Scanning electron microscopy (**SEM**) can elicit information on morphology and provide very high-magnification images with a three-dimensional appearance. SEM may be combined with **energy-dispersive X-ray microanalysis** (**EDX**) to identify the elemental composition of a single paint layer or even a single pigment particle. Although EDX can identify the presence of an element (e.g. iron, arsenic, mercury), it does not indicate the molecular form in which it exists. Therefore the data must be interpreted in conjunction with the examination of paint samples by optical microscopy and other techniques in order to specify whether a particular pigment is present.

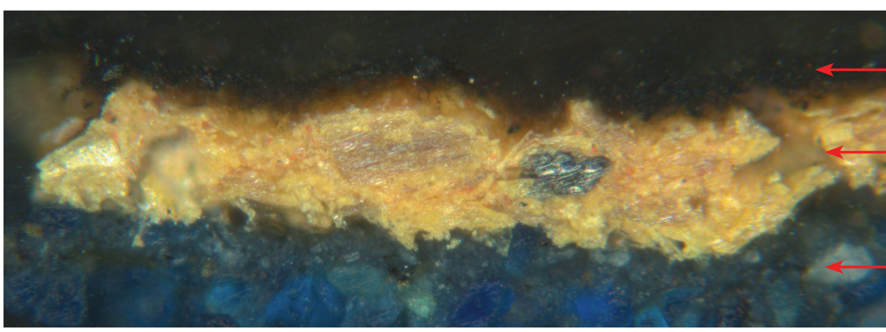
Samples were analysed by the National Gallery Scientific Department using a Cambridge Stereoscan 200 SEM with an Oxford Instruments X-ray detector and Inca software. Elemental analysis of paint samples was carried out on loose samples attached to carbon stubs on a Rontec ESEM system fitted with a Rontec analyser by Dr Brian Singer.



Cross-section of an original Italian Renaissance gilded scheme from the gilded area in the entablature frieze of Frame 2 (594-1869).



Cross-section of an original blue painted finish from the background of the pilaster frieze of Frame 2 (594-1869) showing an azurite paint layer on top of a black underpaint.



Cross-section of an overpainted finish from Frame 13 (7816-1862). The original azurite paint layer has been covered with yellow orpiment overpaint, and there is overlying varnish.

Fourier transform infrared spectroscopy (FTIR) can be used to identify or characterise the binding medium and pigments in each layer. Samples were analysed by the National Gallery Scientific Department using a Nic-Plan FTIR microscope coupled with a Nicolet 5700 FTIR spectrometer. Samples were prepared in a diamond cell and scanned in transmission, 128 times at $4\,cm^{-1}$. Data was manipulated using OMNIC software.

Samples were also analysed by Dr Brian Singer, Northumbria University, using the following method. A sample of each paint, adhesive, coating or plaster was placed on to the diamond window of a Durascope diamond ATR attachment linked to a Perkin Elmer 1000 Fourier transform infrared spectrometer. Each sample was pressed down against the window using a metal anvil and scanned sixteen times. The background scan was automatically subtracted. Each sample was thus analysed by reflectance FTIR.

Raman spectroscopy is a non-destructive analytical technique used for pigment identification. The presence of indigo in a sample taken from Frame 3 (19-1891) was confirmed by Satoko Tanimoto, Mellon Fellow, Department of Conservation and Scientific Research, British Museum. A green (532 nm) laser was used.

Gas chromatography–mass spectrometry (GC-MS) can be used to identify binding media. It can determine the amino acids derived from proteins, thereby identifying which protein is present in the binder. It is also possible to distinguish fatty acids from lipids, oils or resins.

Samples were analysed for the presence of oils, proteins, waxes and resins by Dr Brian Singer, Northumbria University. A portion of samples from Frames 9 (6867-1860), 19 (10-1890), 16 (11-1890) and 10 (1079-1884) was derivatised by acid hydrolysis and then treatment with propan-1-ol and dry hydrochloric acid followed by treatment with pentafluoropropanoic acid anhydride. This procedure gave an opportunity to analyse the amino acids from proteins present as their propyl ester/pentafluoropropanoyl (PFP) derivatives, and also fatty acids derived from any lipids, and oils and resin acids derived from any resins present as their propyl esters.[3]

Samples were transferred to a Reacti-vial and hydrolysed with concentrated hydrochloric acid at 90°C for 3 days. The acid was removed under vacuum and the residue treated with propan-1-ol, dry hydrochloric acid mixture at 110°C for 45 minutes. The excess reagent was evaporated under nitrogen at 50°C and the residue dissolved in 5% solution of pyridine in dichloromethane. Pentafluoropropionic anhydride was added and the mixture was heated to 100°C for 15 minutes. The excess reagent was evaporated under nitrogen at room temperature and the residue dissolved in dichloromethane. This procedure yielded the propyl esters of the *N*-pentafluoropropanoyl derivatives of the amino acids in the proteins and also propyl esters of the fatty acids released by hydrolysis of any drying oil present, which were then analysed by GC-MS. The GC-MS instrument used was a Thermo Focus fitted with a DSQ mass detector.

A layer from a sample was transferred to a Reacti-vial and derivatised by heating to 60°C with two drops of 5% methanolic solution of 3-trifluoromethylphenyltrimethylammonium hydroxide for 4 hours. The mixture was then subjected to thermal decomposition at 250°C before analysis by GC-MS in order to look for evidence of oils, waxes and resins in the sample. The GC-MS instrument used was a Focus GC fitted with a DSQ mass detector. The column used was a Thermo 15m column. The temperature of the column was raised from 90°C to 250°C within the run.

Pigments

The earliest finishes on the frames believed to date from the Renaissance were analysed. Pigments appropriate to the period are listed with information about painted decoration. Pigments found on the V&A frames that came into use at a later date are described below.

Prussian blue (iron (III)-hexacyanoferrate (II), $Fe[Fe^{3+}Fe^{2+}(CN)_6]_3$)

Prussian blue has been widely used in Europe since it was discovered in Berlin in 1704. Prussian blue was found in a later decorative scheme on Frame 1 (5-1890).

Synthetic red iron oxide

Synthetic red iron oxide pigments were manufactured from the eighteenth century. Synthetic red iron oxide was found in the uppermost decorative scheme on Frame 1 (5-1890).

Synthetic (French) ultramarine

Genuine ultramarine is a deep, purple–blue pigment made by grinding lapis lazuli and, in the Renaissance, was more expensive than gold. Synthetic ultramarine, developed in 1826, cost around one-tenth of the cost of genuine ultramarine at that time. Synthetic ultramarine was identified in the uppermost decorative scheme on Frame 8 (5893-1859).

Zinc white (zinc (II) oxide, ZnO)

Zinc white has been in use as a pigment since the late eighteenth century. It was found on Frame 12 (649-1890).

Chrome yellow (lead (II) chromate, $PbCrO_4$)

Chrome yellow was discovered in the form of a natural mineral in the eighteenth century. A number of factories in Europe and the USA were manufacturing synthetic chrome yellows by the beginning of the nineteenth century. Chrome yellow was found on Frame 15 (415-1882).

Naples yellow (lead (II) antimonate, $Pb(SbO_3)_2$ or $Pb(SbO_4)_2$)

Naples yellow is thought to have originated as a by-product of the glass-making industry in the seventeenth century and to have been used widely throughout the eighteenth century. A mixture of Naples yellow and orpiment was used to overpaint original schemes on Frame 13 (7816-1862) and Frame 14 (76-1892).

Bronze paint

Bronze paint is a generic name used to describe paint made with metal powders, usually pulverised brass, mixed with a painting medium. Bronze paint has often been used to colour out losses or abrasion on gilded surfaces since the nineteenth century. When first applied it appears gold in colour but, as the copper element in the metal powder oxidises, it darkens to a dull brown. Bronze paint was found over gold leaf on Frame 10 (1079-1884).

Reference

1. Singer, B. and Mcguigan, R. The simultaneous analysis of proteins, lipids, and diterpenoid resins found in cultural objects. *Annali di Chemica*, 97, 2007. pp. 405–416.