Microscopy and archival research: interpreting results within the context of historical records and traditional practice

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The analysis of paint samples is an invaluable tool in the armoury of historic paint research. However, powerful as the techniques of pigment, cross-sectional and instrumental analysis may be, they cannot always provide complete answers to the questions posed. Historical records relating to specific buildings and projects, as well as painters’ manuals recording traditional painting techniques can offer clues which are vital to solving analysis puzzles. Historical text records which are particular to buildings and/or paintings can provide definitive dates for paint schemes which could otherwise only be dated approximately if key ‘marker’ pigments with known dates of introduction or obsolescence are present. Reference sources may be useful in suggesting or guiding proposed research and conversely, sample analysis can lead to a reassessment of archive records and a refinement of their interpretation.

The application of cross-sectional analysis to the investigation of architectural paint was pioneered in the 1970s by Ian Bristow and Josephine Darrah. During my research degree I was fortunate enough to study microscopy with Jo Darrah at the Victoria and Albert Museum. This training, together with my painting conservator’s understanding of artist’s materials and techniques, informs my daily practice, which is the examination of paint finishes within historic buildings.

Over time I have come to consider myself a ‘paint detective’ more than a microscopist. The identification of painting materials is the core of my work, but I am constantly required to present results within the larger context of an historic building. Therefore, I specialise in the interpretation of microscopic data — paint dates, associations, presence or absence of significant layers — to inform practical building conservation, presentation or redecoration decisions. To fulfil this role, I look to a broad range of clues, drawing from diverse sources, such as standing structure archaeology and archival research — using all pieces of evidence available. Paper based archives such as accounts, correspondence and diaries, and artists images, tend to be site specific. More general but often very valuable are the traditional trade and painters’ manuals. Sometimes written information can be contained within the ‘physical archive’ of the paintings themselves, for example, restorers’ inscriptions, or artists’ signatures. The ‘physical archive’ can also include comparison with samples from other equivalent paintings and structural evidence, such as alteration of window or door openings which would have affected the painting.

Over the following pages, I discuss four case studies where the combined use of microscopy and archival research has proved rewarding.
Burghley House

In Burghley House, Lincolnshire, there survives a remarkable sequence of rooms painted by the Italian artist, Antonio Verrio. Verrio is credited with bringing the Baroque mural style from Italy, via the French Court of Louis XIV, to England and he became the premier artist of this genre. His rich ebullient work reflects the celebratory mood prevalent among English aristocrats during the Restoration period, and the Baroque style of decorating grand interiors became highly fashionable from the 1660s until the first quarter of the 18th Century. During the 1690s Verrio was working extensively for the 5th Earl of Exeter at Burghley House and between 1694 and 1696 he decorated the magnificent Heaven Room with images of 'Neptune and his Court', an 'Assembly of the Gods', 'Venus caught in Vulcan's net' and 'Cyclops forge' complete with a self portrait.

Verrio’s work at Burghley is well documented and records survive not only of materials which were purchased, but also the assistants employed, some for colour grinding and others for more specialised tasks such as flower painting and gilding. The splendid Heaven Room paintings have remained in very reasonable condition, with only one recorded historic intervention by the painter Thomas Stothard who carried out some restoration during 1801. They have recently been conserved by Mike Cowell. The Verrio Burghley archive is a very rich source of information on painting materials, including lists of binding oils, brushes, ‘pencils’ and

Fig. 1. The Heaven Room, Burghley House, painted by Antonio Verrio between 1694 and 1696. © Burghley House, Lincolnshire

Fig. 2. Detail of Venus in the Heaven Room showing horizontal and vertical pentimenti from underlying architectural elements together with disfiguring delamination and cupping of specific areas of painted drapery overlying the architectural elements.
cloths bought, as well pigments purchased and brought from London. Also delightful are the incidental insights into the Italian’s life suggested by the mention of food items, such as the purchase of anchovies and a ‘special Bolougue sausage’. The Verrio Burghley archive pigment list included some but not all of the pigments identified by microscopy. For example, red lake was found on samples, and numerous lakes were listed on the purchase dockets. However, the presence of azurite, yellow orpiment and orange red realgar pigments was identified only through analysis.

In looking at paint samples from the Heaven Room, understanding of the structure and defects of the painting was greatly enhanced by the reading of contemporary painting treatise and correspondence. One of the issues of large scale wall paintings is how they may be transferred from small designs to often vast wall surfaces. Various techniques were used on the Continent to achieve this transfer. A common method was the use of full size cartoons, which were traced onto the wall by prickling holes in the outlines and pressing a bag of black pigment along the holes, leaving a series of ‘pouncing’ dots delineating the edges of features. Charcoal or painted lines as under drawing for designs are also commonly seen. Therefore, it was initially puzzling that no evidence for either of these techniques was found in paint samples. Instead it appeared from the presence of numerous ‘architectural’ paint layers in cross-sections and by examination in situ of raised outlines of pillars, pavements and lintels in raking light beneath overlying figure painting and occasional pentimenti, that Baroque muralists relied on the completion of a painted architectural ‘stage’, which became a framework for the figurative ‘history’ work. Interestingly, contemporary writing by the author Dudley Ryder, who visited Thornhill (a later rival of Verrio) whilst he was engaged in painting the interior of the Dome of St Paul’s Cathedral, corroborates visual and analytical evidence. Ryder noted that the trompe l’oeil architecture was finished, the gilding partially done, but that none of the ‘history part’ had been painted.

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At Burghley, as well as identification of the constituent materials, a further aim of research was to investigate the cause of the disturbing cupping and disruption of the paint — a defect which appears on many Baroque murals is a distracting ‘alligator’ craquelure. The craquelure has an appearance which is generally associated with poor drying of an oil medium, where the upper paint surface has contracted to form a series of scales. However in the paintings studied, this drying cracking appears to be associated as much with the number of underlying layers of ground, architecture etc. as with an inherent fault in the paint mixtures. The number of layers present appears to relate to ‘studio’ practice as discussed above.

Several pieces of documentary evidence, not just at Burghley but elsewhere, refer to preparation of
plaster surfaces for painting by artists. The Burghley archive records that on 5th August 1691 Verrio ‘Rec’d three pounds six shillings in full’ for double priming the Second George Room, at eight pence per yard. Techniques for the preparation of plaster to receive oil paint are given in contemporary texts such as John Smiths ‘Painting in Oyl’, published in the 1680s. Methods focus on drenching the wall with boiled oil to satisfy its porosity but also as a damp proofing technique. Baroque murals usually have a red sealant – the ‘boiled oil’ recommended in texts augmented with red pigments. Often the pigment is red lead, which through its siccative properties would have enhanced the hardening of the oil film, but sometimes the pigment is merely iron oxide. The colouring of the sealant is not discussed in texts and was probably a pragmatic innovation, as it clearly showed where the compound had been applied.

St Martin-in-the-Fields

The second case study focuses on the church of St Martin-in-the-Fields, which overlooks Trafalgar Square in London and was constructed to the designs of James Gibbs between 1722 and 1726. The fine ornamental plasterwork to ceiling and walls was carried out by the Italian craftsmen Giovanni Bagutti and Giuseppi Artari. Our brief was to identify the original decorative scheme that accompanied the plasterwork. In addition to taking nearly four

Fig. 4. Photomicrograph showing a sample from the cracked drapery in cross-section. Photographed in dark field reflected light at 200x magnification. The sample illustrates deterioration of the upper paint layer; it appears the yellow orpiment is undergoing alteration to white arsenic trioxide. Red lake and natural azurite pigments can be seen in the paint layers below the orpiment layer.

Fig. 5. Photomicrograph showing a sample from the cracked drapery in cross-section. Photographed in dark field reflected light at 200x magnification. The sample illustrates the separation of the upper paint layers from the lower paint layers. Thomas Stothard’s varnish can be seen both on the surface and surrounding the edges of the paint flake.

Fig. 6. Detail of Bacchus’s head in the Heaven Room showing the disfiguring ‘alligator’ craquelure which appears on many baroque murals and appears to be associated with aspects of original technique, in particular the sequential application of numerous paint layers representing trompe l’oeil architecture. The left side (as seen) of Bacchus is sound, whilst the right is damaged. Dark areas have noticeably more severe craquelure, and it is probable that more than one phenomenon is affecting the paint in this area.
hundred samples from the vast interior; we were commissioned to undertake research into the archives to establish the extent of written records relevant to the decorative history of the interior. The large sample number is not only a reflection of the vast size of the church interior, but is a requirement of architectural paint research methodology which establishes full decorative history by comparative examination of co-eval decorative strata across different samples. The broad approach is aimed at clarifying distinct decorative phases and identifying structural alterations, as well as the colours and materials of separate decorative schemes.

Excitingly, the church archives proved to be rich in records relevant to the original decoration. For example, the Construction Committee minute survives which states “that Mr. Bagutty is the proper person to be employed to do the fret work of the ceiling and the gilding necessary to be done about the church who demanded for the doing of such work the sum of £320.” In 1726, bills submitted by Messrs. Abbot & Stokes outlined the elements which were to be painted; of particular interest was the mention of “3451/2 yard painting on stone 4 times in oyl at 11/yard 20:3:1” and also “Messrs. Abbot & Stokes - By No. 42 1/2 faces of Corinthian capital painted at…6:9:0”.

The subsequent history of redecoration was found to be less well documented, as faculties (permissions) have not always been sought. However, various interesting records do survive. In 1758 the Vestry initiated a programme of redecoration which centred on the Chancel and a significant redecoration occurred in 1897 when Harrods agreed to pay £1,400 for the “decoration of the church”. Research amongst decorators practicing today identified two modern redecorations in 1961 and 1976-7.

Initially interpretation of the samples taken was rather confusing, because samples from the Apse had numerous traditional oil and lead based stone colour paint layers, whilst others from the main

Fig. 7. St Martin-in-the-Fields Church, interior view of the Apse ceiling.
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Fig. 8. St Martin-in-the-Fields Church, interior view looking west towards the organ.

body of the church only bore evidence from the mid 19th Century onwards. Why had the evidence of 18th Century paint in the Nave ‘disappeared’? Enlightenment came from careful reading of the original accounts and a trip back to the church to measure the size of the Apse. Mr Stokes had only painted ‘345½ yards… in oyl’ and this is the size of the Apse. The main body of the church would have been more cheaply decorated using soft distempers, a water washable finish traditionally removed each time a new redecoration is applied. Distempering was considered as part of the plasterer’s work, not as a separate job for painters and therefore no original record survives for this decoration.

Interestingly the original decoration reflects the liturgical hierarchy of the internal spaces in the expense, number and type of paint finishes applied. From construction until the late 19th Century the Apse was the focus of the interior decoration. On paint samples from the Apse evidence of the temporary ‘Builder’s finish’ distemper is present, swiftly followed by the first decoration employing oil bound paints, which was present upon consecration of the church. The analysis of paint samples bears mute witness to the accuracy of the archive records, as physical evidence from the paint samples tallies with the descriptions of painting recorded in the archived bills. The original decorative scheme presented the Apse, coated four times with oil...
bound paints in stone colours, enriched with gold leaf gilding to carved and moulded details. The 1726 design used simple distemper finishes within the main body of the church, except for the column capitals and door or window surrounds which were coated with oil bound paints. No gilding was present within the Nave.

Samples record the repetition of the original paint scheme, with only minor variation, on eleven occasions, with five associated re-gildings. As the original scheme was repeated the use of oil bound paint spread gradually out onto the Nave walls. However, from the mid-19th Century oil bound paints were introduced to the Nave ceilings, along with gilded highlights throughout. This introduction of gilding to the entire church interior marks a significant shift from the Apse centred original design which had survived almost unchanged from 1726 to the 1850s. At the close of the 19th Century another major alteration to the interior decoration of the church was made when Harrods financed an expensive redecoration of the church. The significant Harrods decoration of 1897 has been revealed by paint analysis to be a complex polychromatic scheme of a typically high Victorian character. This design not only reaffirmed the use of gilding throughout the entire church, but also introduced vivid colour for the first time. The polychrome decoration was repeated on two further occasions, with slightly simplified designs. The polychrome was replaced by a light coloured decoration in the 1960s and most recently by the design, currently visible, which was applied in the 1970s.

Fig. 9. St Martin-in-the-Fields Church, sample from the Apse which shows the early stone colours and the presence of a trace of distemper at the base of the sample. Distemper is a soft porous paint composed of chalk bound in animal glue and coloured with pigments. It is a relatively soft finish and remains resoluble in warm water and was commonly removed prior to redecorating. Always applied over fresh lime plaster to allow the plaster to carbonate, harden and dry out fully. Photographed in dark field reflected light at 200x magnification.

Fig. 10. St Martin-in-the-Fields Church, sample from the Apse, which shows the original gilding overlying the original paint scheme of four layers of stone colour paint. A further five gilding schemes are present, before the area is painted plain white, probably during the early 20th Century. Photographed in dark field reflected light at 200x magnification.
The third case study examines paint history within St Paul’s Cathedral, the masterpiece of Sir Christopher Wren, which was constructed between 1675 and 1708. The Dome of St Paul’s Cathedral was painted by Sir James Thornhill between 1717-19 at a cost of £4,450. The Whispering Gallery walls were painted during 1719-21 for an additional cost of £2,125. A massive restoration of the Cathedral has been underway for some years, timed for completion by 2008, the Cathedral’s three hundred year anniversary. We were commissioned to examine Thornhill’s work, and in particular to identify the original Thornhill scheme to the Tambour and Whispering Gallery wall, if it survived below later plain architectural paint. The Whispering Gallery walls were painted plain white at the time of sampling. Not surprisingly given the importance of St Paul’s Cathedral there is a wealth of art historical material relating to the building. Through paint research it was possible to identify the Thornhill decoration on the Whispering Gallery walls and to establish that it survives, albeit in poor condition, below later plain overpaint. Furthermore it was possible to relate the art historical information with the physical evidence presented by the paint samples and to chart the time line of alterations to Thornhill’s work.
Early prints and engravings of the Cathedral interior suggested a Thornhill scheme that emphasised and embellished the actual three dimensional architecture of the drum. Thornhill achieved this by painting fictive fluting on the column faces, scalloping in the niche heads, crossed swords and festoons in the panels below the windows, and swags above the niches and windows. John Gwyn’s design of 1755/6 shows trompe l’oeil swags and crossed swords in the plain panels below the windows and larger figurative panels to the Whispering Gallery wall. Coney’s 1818 engraving of the interior also shows large rectangular frames, presumed to be Thornhill’s paintings, on the walls of the Whispering Gallery. A.W.N. Pugin’s ink drawing of May 1828 indicates fictive panelling with crossed swords and swags below the windows, fluting to the faces of the columns and scalloping within the niche heads, however no panels to the Whispering Gallery walls.

During in situ examination of the walls from scaffolding, evidence was found of crossed swords and swags in the panels below the windows, as the raised edges of paint were clearly visible in raking light, although thickly overpainted. The sampling strategy was planned therefore to prove or disprove the accuracy of the early engravings. A systematic sampling programme was devised which included
careful removal of samples, across a 5000 mm width of the Whispering Gallery wall at 150 mm intervals at two thirds of the height of the wall. Further samples were taken from the centre of this line up to the enriched band at the top of the Whispering Gallery wall and again at 45 degrees from the left of the intersection of the two lines up to the enriched band. Samples were also taken from all accessible areas of the tambour. In addition to the evidence provided by visual sources, archive texts supplied further information that proved useful in assigning dates to later plain architectural overpaint and gilding.

Evidence of Thornhill decoration was identifiable on cross-section samples from both the Whispering Gallery walls and Tambour. As archive sources suggest, trompe l’oeil work was executed on these surfaces and remained exposed for a number of years. Comparison with Thornhill’s technique, as seen on samples from the inner dome, proved invaluable in confirming the presence of the artist’s work lower down in the drum. On the lower areas a similar technique was identified; a thin red medium-rich sealant, applied over the stone and plaster substrates, followed by a two coat application of a pink coloured ground and a third beige coloured ground. Paint layers were applied directly onto the surface of the ground. The thickness and number of paint layers present depends upon the complexity of the trompe l’oeil design. For example, the majority of the Whispering Gallery walls has a single uniform buff ‘stone’ coloured paint, but higher up in the rectangular panels of the Tambour, where fictive swords and festoons were painted, the paint layers are more numerous and complex.

The Whispering Gallery walls were overpainted at some time during the 19th Century: the presence of barytes in the first overpaint confirms this approximate dating. Archive sources suggest that in 1856 the paintings of the Tambour were still extant as the Trustees considered ‘the repairs of paintings in the drum… [for] £800’ but decided not to proceed and to reconsider at some future date. In 1860 the Chapter Minutes, St Paul’s Library, record that the ‘cost of re-gilding and cleaning the walls of the Drum has been provided for by the St Paul’s Cathedral Fund’. It seems probable that the reference to cleaning is rather euphemistic and would be more accurately understood to mean overpainting of the trompe l’oeil design. It is clear from examination of the samples that the condition of the Thornhill decoration was probably fairly poor when it was obliterated by application of a thick off-white overpaint. Paint samples reveal that the Thornhill painting had suffered from cracking, delamination (at the interface of the substrate and preparatory paint layers) and subsequent loss.

Samples from the Whispering Gallery railings show an interesting decorative history: the first six paint schemes are all ‘iron’ colour (a mid-grey), followed by a single stone colour decoration. Schemes eight and nine were ‘iron’ colour again. The tenth decoration marks a significant change with the introduction of ‘faux’ gilding, consisting of a
varnished yellow ochre paint on beige undercoat. There is an archive reference in 1789 to painting of ‘232 Yds fine yellow to Whispering Gallery – 5d - £4.16.8’, and it seems probable that the ochre ‘faux’ gilding dates from this time. The eleventh scheme repeats the ‘faux’ gilding using varnished chrome yellow paint on beige undercoat. The twelfth and final decoration consists of gold leaf on oil size and yellow ground on white undercoat. Archive references suggest that the rails of the Whispering Gallery were gilded in 1860 at the same time as regilding of the Tambour.

The Dean and Chapter and the Surveyor to the Fabric of St Paul’s Cathedral made the brave decision to recreate the Thornhill designs using traditional paints, matched to Thornhill’s materials. Visitors to the Cathedral today can once again see trompe l’oeil in the Tambour linking the painted dome to the main body of the Cathedral.

**Queen’s Staircase - Hampton Court Palace**

The fourth case study explores the Queen’s Staircase, Hampton Court Palace, which was decorated by William Kent in 1734. William Kent superseded artists such as Verrio and Thornhill to become the dominant decorative artist of the second quarter of the 18th Century. He introduced a more geometric style of ceiling and wall painting, following the Roman tradition. Kent was also a successful and prolific architect, furniture designer and gardener. The staircase ceiling is painted with a trompe l’oeil coffered dome centred on a Garter Star and supported by grisaille figures and ornament. There is a long recorded history of interventions, restoration and conservation of the ceiling. However, once again the ceiling is the cause of concern due to extensive flaking and delamination of the painting. Historic Royal Palaces, who have care of Hampton Court, have instigated an on-going programme of recording (as part of their preventative conservation programme), and emergency treatment by a specialist wall painting conservator is in place, together with an environmental monitoring campaign, commenced in 2001. We were commissioned to undertake sample analysis and I have collaborated with Dr Nicholas Eastaugh on this project.

The Queen’s staircase was painted in a consummately skilful and direct style using oil bound pigments and gilding on a lime plaster and riven oak lath support. The artist’s preparation for painting comprises a considerable build-up of a red sealant layer together with a triple ground, applied in three separate layers. Over the preparation the design was created from a relatively simple application of paints, generally as opaque layers, with translucent paint glazes used to add depth, colour and richness to the design. Techniques for laying out of the design, such as pencil marks, incisions in wet paint and pouncing (carbon tracing) marks are present.
The presence of a friable chalk layer between the plaster support and the painting appears likely to be the cause of delamination and flaking. Comparable samples of Kent’s painted State Bedroom ceiling at Houghton Hall, Norfolk, do not bear the same chalk layer below the sealant. The origin of the chalk layer on the ceiling of the Queen’s staircase may never be known with absolute certainty. However, it seems possible that it is present due to an oversight by Kent, in omitting to remove an earlier plasterer’s water-based paint, rather than as a deliberately planned application by Kent and his assistants. It was common practice for fresh lime plasters to be ‘finished’ with a porous water-based paint, whilst the lime plaster was allowed to carbonate, pending any...
application of architectural or decorative oil-bound paint. Furthermore it was usual for ceilings to be redecorated with a simple white finish of whiting or whitewash, with more expensive oil-based paint being reserved for areas likely to be subject to abrasion. The water-based paints were simple formulations of chalk, lead white, lime and/or satin white mixed with dilute solutions of animal glue size. Preparation of the ceiling by Kent’s assistants appears to have ignored the presence of ‘whitening’ and inadvertently applied the robust oil bound preparation layers over a weak and unstable earlier paint.

*Figures 2 - 17 and Figures 19 & 20 © Jane Davies*

**Conclusion**

These case studies illustrate the huge potential of paint analysis in solving historic paint riddles. As powerful as the techniques of pigment, cross-sectional and instrumental analysis undoubtedly are, they cannot always provide complete answers. Historical records and painters’ manuals can offer clues which are vital to solving analysis puzzles. Interdisciplinary research and co-operation between specialists provides a much fuller understanding of traditional painting practice and the physical history of specific paintings and buildings.

Field widths unavailable at the time of going to press. These will be provided in the next issue of *infocus* for reference, and are available online at [www.rms.org.uk/infocus](http://www.rms.org.uk/infocus).

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