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Two Wings of an Altarpiece by Martin van Heemskerck

Jill Dunkerton, Aviva Burnstock and Alistair Smith

Introduction

Alistair Smith

In the Autumn of 1986, the National Gallery acquired two panels attributed to Martin van Heemskerck (Nos.6508a,b; Figs. 1–4; Plates 1, 2, 4, 5, pp.33, 40). One panel shows the Virgin on one knee, supported by Saint John the Evangelist. She is clearly distressed. The other displays the kneeling donor, a canon, attended by Saint Mary Magdalene.

On acquisition the reverses of these wings showed two (unidentified) bishop saints, in grisaille, subtended by blank escutcheons painted red (Figs. 3 and 4). The paintings had frames which were found to be old, but not original. An account of the cleaning, restoration and technical examination is given below by Jill Dunkerton and Aviva Burnstock.

The frames showed marks where hinges were once attached. This consolidated the obvious compositional evidence that the paintings had originated as the wings of a triptych. Indeed, they are published as such in the monograph on Heemskerck by Rainald Grosshans [1].

Grosshans makes the following observations. First, that the grisaille saints are by a workshop assistant, rather than by Heemskerck himself. Second, that the lost centre panel must have shown an *Ecce Homo* amidst clouds. He points out that a painting dated 1532 (Ghent, Museum voor Schone Kunst (Fig.5)) would be a candidate, were it not the wrong size. He concludes that the lost centre panel was probably a larger variant of this composition.

As for the date of the paintings, Grosshans makes comparisons both with the Ghent painting of 1532 and with a painting of 1536 (*Vulcan presents Thetis with the Shield for Achilles*, Vienna, Kunsthistorisches Museum), where he sees a profile similar to that of the Magdalen in the National Gallery painting. He therefore leaves the painting's date of creation unspecified.

Normally, a difference of four years in dating might not be crucial in the career of an artist who was active for more than forty years. Heemskerck himself, however, saw the years 1532 to 1536 as being particularly important for him since he spent them in Italy. The significance of his time in Rome is evidenced by his well-known *Self-Portrait* (Fig.18; Cambridge, Fitzwilliam Museum), which, although painted as late as 1553 shows the artist posed in front of the Colosseum where he had studied twenty years before. Further, Van Mander relates that Heemskerck went so far as to categorize his work as being pre- and post-Italian, and tells that Heemskerck commented on his earlier period, '[...] at that time I did not know what I was doing'. Consequently, it is of particular importance to distinguish between work made before his departure for Italy

in 1532 and paintings created after his return to the Netherlands in 1536.

It seems fairly obvious, considering the cleaned paintings, that they belong to the post-Italian period. As Grosshans points out the so-called 'Grecian' profiles of Saint John and the Magdalen reflect the influence of Heemskerck's classical studies. One might add other post-Italian characteristics such as the diaphanous drapery and classical jewellery of the Magdalen, her 'antique' coiffure and her sinuously arranged pose. In addition, the dramatic intensity of the Virgin's pose is far more developed than anything in the pre-Italian period. It is not until the Linköping altarpiece of 1538–1542, that anything comparable exists. In addition, the thin, fluid execution of the standing figures and the speedy flickering treatment of the donor's fur stole all result from the Italian journey. This visual assessment of the painting accords completely with the technical evidence below.

Only one detail might make one hesitate to date the painting in the post-Italian period. It is the portrait of the donor, his head being constructed in the thicker manner of the early years when the influence of Scorel was strong. Fresh and vital, so obviously part of the great tradition of closely-observed Netherlandish portraiture, it is in complete contrast to the thinly-painted, idealized heads of the saints. One might think it pre-Italian were it not for the fact that Heemskerck's portrait style preserved this characteristic until well into the 1540s.

If the paintings are datable to after the Italian journey, as all evidence now suggests, then it is reasonable to search for a different central panel. One image which might be considered is the *Ecce Homo* (Greenville, Bob Jones University Art Gallery), which has the substantial clouds of the National Gallery wings and the slightly porcine hands of the participants (Fig.6). Unfortunately, its dimensions do not accord, but I offer it as a reduced, slightly later, variant of the original central panel.

Of course, much less speculation about dating might be achieved, together with other advances in knowledge when a secure identification of the coats-of-arms has been achieved (Plates 4 and 5, p.40).

Reference

1. GROSSHANS, R., *Maerten van Heemskerck, Die Gemälde* (Berlin 1980), no.17, p.109. Grosshans records that the paintings were first attributed to Heemskerck by S.J. Gudlaugsson in 1952.

Treatment

Jill Dunkerton

Cleaning and restoration

If their condition permits, new acquisitions at the National Gallery are often displayed for a few months before being removed from exhibition for what may be a lengthy conservation treatment. However, *The Virgin and Saint John the Evangelist* (No.6508a) and *The Donor and Saint Mary Magdalene* (No.6508b) (Figs. 1 and 2; Plates 1 and 2, p.33) had to undergo immediate treatment, partly due to concern over the restriction of the panels by their frames, but mainly because *The*

Virgin and Saint John the Evangelist had already been partially cleaned. Comparison with the uncleaned *The Donor and Saint Mary Magdalene* and the two bishops in grisaille on the reverses (Figs. 3 and 4) suggested that this cleaning involved little more than the removal of the more readily soluble upper layers of varnish. Most of the old retouching, together with the remains of earlier varnish layers, had been left.

The surviving varnish on *The Donor and Saint Mary Magdalene* was fairly thin and only moderately discoloured but sufficiently so to mute the effects of van Heemskerck's distinctive palette of hot reds and pinks set against brilliant greens and turquoise blues. It was easily dissolved, leaving the same opaque and clumsy retouchings apparent on the other panel. These were removed



Figure 1 Martin van Heemskerck, *Wing of an Altarpiece: The Virgin and Saint John the Evangelist* (No.6508a), panel, painted surface 123 × 46 cm. Before treatment.



Figure 2 Martin van Heemskerck, *Wing of an Altarpiece: The Donor and Saint Mary Magdalene* (No.6508b), panel, painted surface 123 × 46 cm. Before treatment.

from both pictures with dilute ammonia or mechanically with a scalpel if particularly thick and solid. They were found to cover minor flake losses, splits and cracks in the panels and areas of abrasion where the raised grain of the wood has often broken through the thin layers of paint and ground. Unfortunately, worst affected are the heads of the donor and of the two saints (Figs. 7 and 8). The uneven discoloration caused by the remnants of earlier varnish layers could be reduced to some extent by further cleaning with dilute ammonia but both paintings were still disfigured by vertical lines of circular, orange-brown stains, exactly as if something had been dripped or splashed onto their surfaces (Fig.8). The amount present was far too small to attempt identification of the substance but it appears to have bitten slightly into the

paint surface, making its removal virtually impossible without causing further damage. Consequently it was decided to retouch over the most disturbing splash marks. Apart from this, retouching was limited to the flake losses, splits and worn areas. In a few places where the underdrawing was particularly obtrusive, for example in the mouth and chin of Saint John the Evangelist, where it contradicts the painted form (Fig.7), it was lightly touched out [1].

As is often the case, the grisaille paintings on the outer surface of the wings presented a somewhat battered appearance. To help disguise the various dents, scratches and gouges, the varnish covering the grey paint of the stone niches had been tinted a deep, chocolate brown colour, possibly with a bituminous paint [2]. While this



Figure 3 Martin van Heemskerck, *Wing of an Altarpiece: A Bishop Saint subtended by a coat-of-arms* (No.6508a). Reverse before treatment.



Figure 4 Martin van Heemskerck, *Wing of an Altarpiece: A Bishop Saint subtended by a coat-of-arms* (No.6508b). Reverse before treatment.



Figure 5 Martin van Heemskerck, *Ecce Homo*, panel, 84 × 72 cm. Ghent, Museum voor Schone Kunst.

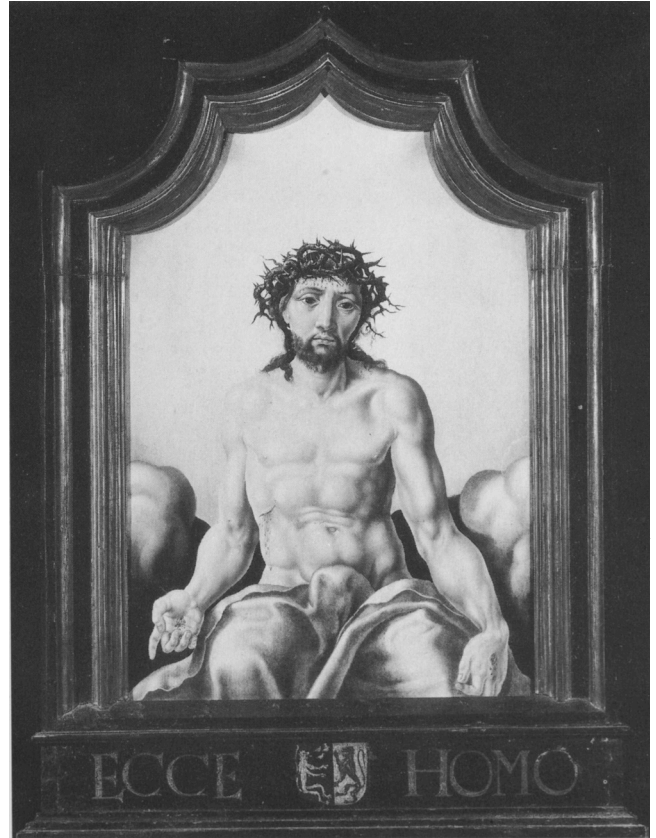


Figure 6 Martin van Heemskerck, *Ecce Homo*, panel, 77.6 × 54 cm. Greenville, South Carolina, Bob Jones University.



Figure 7 *The Virgin and Saint John the Evangelist*. Detail, after cleaning, before restoration.

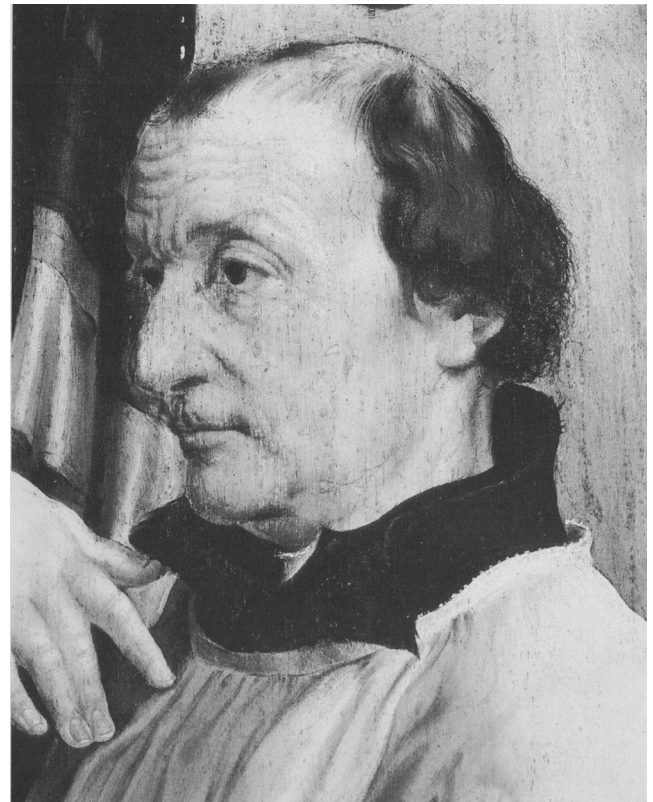
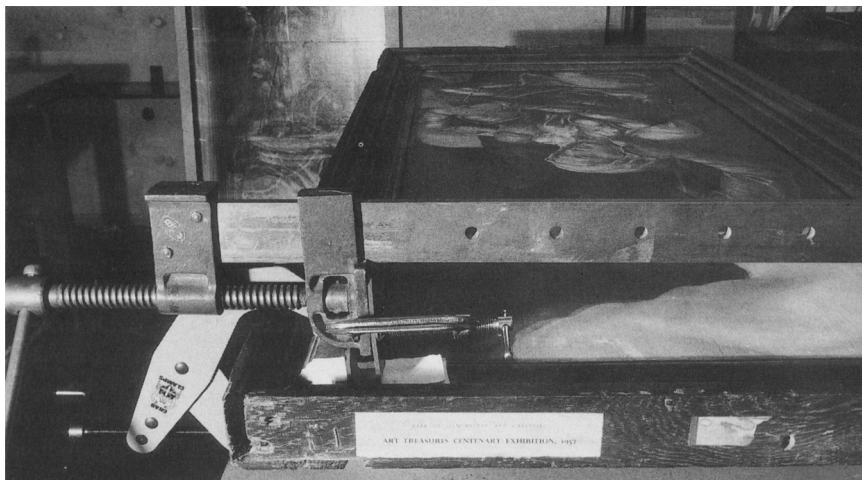


Figure 8 *The Donor and Saint Mary Magdalene*. Detail, after cleaning, before restoration.



could easily be removed, normal cleaning solvents did not have any effect on the solid red paint of the trompe l'oeil carved shields. Although X-radiographs and infra-red photographs (Figs.28–31) showed this red paint to be covering coats-of-arms, it was evidently of considerable age so it was decided not to attempt its removal until a full scientific study had been made of the original paint and of the putative repaint.

The panels and frames

The frames around the two panels [3] were rather rough-and-ready constructions of oak, painted black and with parts of the moulding picked out in gold. While features of their joinery suggested that they were unlikely to be the original frames, they were clearly old and the presence of hinge marks and a raised beading and grooved channel (on the left and right wings respectively) which interlock when the wings are closed, proves that they date from before the dismantling of the altarpiece and the disappearance of the central panel. Neither panel fitted particularly well into their frames. The unpainted borders were visible in places and the panel of *The Virgin and Saint John the Evangelist* was jammed in the rebate allowing no room for any expansion and contraction of the wood. As a result the panel had developed several splits and checks. The other wing presented a different problem. It was not so tightly restricted by its frame but the original join between the two planks had opened up along most of its length. Access to the join to effect a good repair was impossible. Therefore before either panel could be treated the frames had to be removed.

To avoid sawing through the frames which were to be re-used to exhibit the paintings, it was necessary to devise an elaborate clamping system (Figs. 9 and 10) to force them gradually apart at the mitred corners. The X-radiographs (Figs. 11 and 12) showed that these corners had all been secured with at least two nails, some more than 8 cm long. By slowly winding out the sash clamps it was possible to open two opposite corners, concentrating on those with the shortest nails (identified in the X-radiographs), and eventually to remove each frame in two L-shaped sections.

Once released, *The Virgin and Saint John the Evangelist* immediately developed a slightly twisted warp at right

angles to the direction of the grain of the wood. Clearly it had been under considerable tension. Conversely the other wing had virtually been held together by the frame: on removal it was only prevented from falling apart into its two constituent planks by the four dowels visible in the X-radiograph (Fig.12). Wooden dowels appear to have been used not only to reinforce the joins but also to peg the panels into their original frames. Regularly-spaced rows of small round holes were revealed along the unpainted borders of the panels (Figs. 13 and 14). These holes are best preserved along the right edge of *The Donor and Saint Mary Magdalene*. The top and bottom edges tend to be rather ragged while the left edges of each panel have been trimmed and slightly planed, shaving off the *barbe* and cutting through the dowel holes. Evidence of similar fitting of the panel using dowels has been found on other works by van Heemskerck and may be a characteristic of his workshop [4]. The absence of any traces of these dowels in the present frames is further proof that they are not original.

This discovery dispelled any remaining qualms about altering the frames to prevent restriction of the panels. The frames were sliced through as near to the back edge as possible (to avoid cutting through the beading and channelling of the closing mechanism) and new pieces of oak inserted. This increased the depth of the frames by approximately 2 cm making room for sufficient foam cushioning [5] to be packed into the rebate to allow for a certain amount of movement, even of the slightly twisted panel. When the repairs to the panels [6] and the restoration of the paintings had been completed, the frames were reassembled around the panels and the mitred corners secured with screws. As there are no plans at present to show the grisaille paintings on the reverses, it was necessary to protect them, not with normal backboards which would have damaged the backs of the frames, but with specially constructed trays. These are attached through the sides of the trays and into the inset pieces of new timber. All the additions have been coloured and polished to match the old parts of the frame.

The solution of the peculiar problems encountered in the treatment of these altarpiece wings owes much to the close collaboration between the Conservation and Framing Departments. It also underlines the importance for the future conservation of a painting of the frame and the fitting of the painting into the frame.

Figures 9 and 10
The Virgin and Saint John the Evangelist, during removal of the frame.



Figure 11 *The Virgin and Saint John the Evangelist*, composite X-radiograph with the frame.



Figure 12 *The Donor and Saint Mary Magdalene*, composite X-radiograph with the frame.



Figure 13 *The Virgin and Saint John the Evangelist*, after cleaning, before restoration (removed from the frame).



Figure 14 *The Donor and Saint Mary Magdalene*, after cleaning, before restoration (removed from the frame).



Figure 15 Detail from Martin van Heemskerck, *Saint Luke Painting the Virgin*, panel, 168 × 235 cm. Haarlem, Frans Hals Museum.



Figure 16 Detail from Martin van Heemskerck, *Saint Luke Painting the Virgin*, panel, 205.5 × 143.5 cm. Rennes, Musée des Beaux-Arts.

Materials and technique

Jill Dunkerton and Aviva Burnstock

In the course of the treatment of van Heemskerck's paintings samples were taken from their edges and from splits, cracks and flake losses for investigation by the Scientific Department. Methods used included the examination of paint samples in cross-section, and in some cases in thin cross-section, to establish the order of paint application and to identify pigment mixtures. Pigments were identified by optical microscopy, X-ray diffraction analysis and EDX microanalysis in the scanning electron microscope (SEM). In addition element mapping was carried out by SEM-EDX on selected cross-sections. Identification of the organic components of the paint and preparatory layers was by gas-chromatography-mass-spectrometry, supplemented by staining tests. Further technical information was supplied by X-radiography and infra-red photography.

There were several reasons for making such a comprehensive examination of the materials and techniques used on these two panels. Although the techniques (and in particular the underdrawing) of sixteenth-century Dutch painting have been quite widely studied elsewhere [7], this period is poorly represented in the National Gallery Collection. Therefore the acquisition of van Heemskerck's panels provided our first real opportunity to investigate a work of this School. In interpreting the results of the scientific examination special emphasis was laid on trying to establish connections not only with the methods employed in Northern European painting of the fifteenth- and early sixteenth-centuries, but also with the panel painting techniques of Dutch and Flemish painters of the next century. In his paintings van Heemskerck has himself left several clues as to his likely working methods: for example, the two versions of *Saint Luke painting the Virgin* (Haarlem, Frans Hals Museum, and Rennes, Musée des Beaux-Arts; details are illustrated in Figs. 15 and 16), the unfinished *Erythraean Sibyl* (Amsterdam, Rijksmuseum, Fig. 17) and in his presumed self-portrait shown sketching in Rome (Cambridge, Fitzwilliam Museum, Fig. 18). The fact that the National Gallery panels almost certainly date from soon after van Heemskerck's return from Rome in 1536 added to their interest as it suggested the possibility of attributing certain technical features to the painter's experiences in Italy [8]. Finally, by identifying the materials and methods used it was hoped to account, in part at least, for the striking and unusual appearance and tonality of the pictures.

Support and ground

Each panel consists of two planks of oak, approximately 8mm thick and with a vertical grain. The butt-joints have been reinforced with wooden dowels (see under 'Treatment') and the edges of the outer surfaces have been bevelled. While bevelled edges are frequently seen on the backs of sixteenth- and seventeenth-century oak panels it seems odd to have done this to panels which were to be painted on their reverses. Little attempt has been made to disguise these sloping edges in applying the



Figure 19 Martin van Heemskerck, *The Donor and Saint Mary Magdalene*. SEM micrograph showing a coccolith in the chalk ground. Gold-coated, 9530 \times .

Figure 18 (Top) Martin van Heemskerck, *Self-Portrait*, panel, 42.3 \times 54 cm. Cambridge, Fitzwilliam Museum.

Figure 17 (Left) Martin van Heemskerck, *Erythraean Sibyl*, panel, 123 \times 76.5 cm. Amsterdam, Rijksmuseum.



Figure 20 *The Virgin and Saint John the Evangelist*. Infra-red photograph before treatment.



Figure 21 *The Donor and Saint Mary Magdalene*. Infra-red photograph before treatment.

ground. The ground on both sides of the panels is the same chalk (calcium carbonate) [9] bound in glue size [10] found on panels of the previous century. Coccoliths indicative of the natural origin of the chalk are visible in SEM micrographs (Fig.19). In those cross-sections where the ground is present it can be seen to have been applied in two distinct layers but the thickness of the ground is noticeably less than that noted on earlier Northern panels. When viewed in raking light, the grain of the wood is quite prominent and it has tended to erupt through the paint layers. In his didactic poem *Den grondt der edel vry schilder-const* (1604), Karel van Mander comments on the tendency for the grounds of his contemporaries to be thinner and less smooth than those on paintings of the fifteenth century: 'Our modern practitioners formerly plastered their panels thicker than we whiten, and shaved as smooth as they were able' [11].

As the ground does not extend to the edges of the panels, but terminates in a slightly raised ridge or *barbe*, it can be assumed that it was applied to the panels when they were already pegged into their original frames (see under 'Treatment'). Documents show that in the Netherlands in the sixteenth century, and indeed in the previous century, panels and their frames were made by specialist carpenters and were delivered to the painters ready assembled and perhaps sometimes prepared with a ground as well [12].

The inner faces of the wings

Underdrawing

Close examination of the infra-red photographs of both inner faces of the wings (Figs. 20 and 21) revealed faint and smudged traces of rectilinear grids as used in the enlargement and transfer to the panel of preliminary drawings made on paper. These lines are most clearly visible in the reddish brown background behind Saint John the Evangelist and in the pale pink dress of Saint Mary Magdalene. A sample taken from a point where a line runs out to the edge of the picture confirmed that the grids had been drawn with charcoal (Plate 3a, p.33) [13]. Most of this charcoal would have been dusted off, either accidentally or deliberately, before the application of subsequent paint layers. Drawings in Copenhagen [14] and Berlin (Fig.22), which are evidently designs for altarpieces, confirm that van Heemskerck practised the technique of squaring up for the transfer of designs [15].

The figures in these drawings are drawn in pen and ink with curving, calligraphic lines and flourishes and without any hatching to indicate shadows or modelling. An almost identical graphic style is seen on a much larger scale in the underdrawing of the figures in the National Gallery panels. The main outlines of the forms have been established with considerable freedom and confidence but they have seldom been adhered to in the painting stage. This disregard for the underdrawing [16] is best illustrated in the heads and hands of all the figures, most

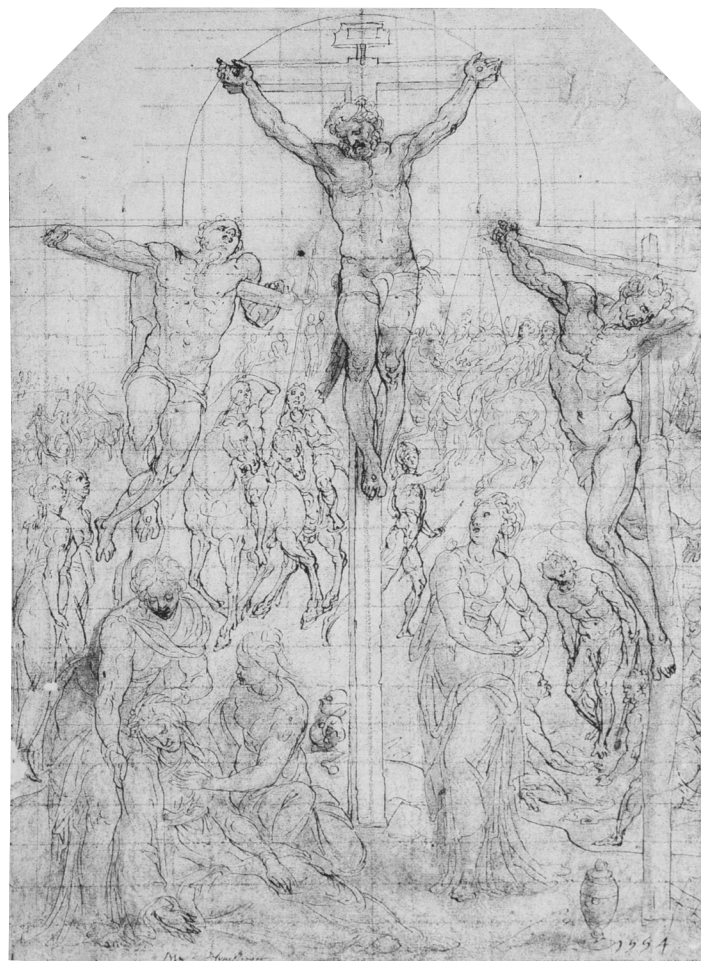


Figure 22 (Right, top) Martin van Heemskerck, *The Crucifixion* (KdZ2780), paper, 37.3 x 26.4 cm. Berlin, Kupferstichkabinett SMPK.

Figure 23 Martin van Heemskerck, *The Donor and Saint Mary Magdalene*. Infra-red detail.





Figure 24
*The Donor and
Saint Mary
Magdalene.*
Infra-red
detail.

strikingly in the profile of Saint Mary Magdalene (Fig.23). Originally this was much more steeply inclined, almost as if she were resting her forehead against the edge of the frame. Two details which were drawn but never painted are of particular interest. The first is the fold or frill sketched in across the thigh of the Magdalen to indicate a tiered skirt (Fig.24). This can perhaps be linked with one of van Heemskerck's sheets of pen drawings made while in Rome which includes a detailed study of the torso of a similarly dressed antique sculpture [17]. The second is the chalice to have been held in the left hand of Saint John the Evangelist (Fig.25). The discovery of this hidden attribute provides absolute confirmation of the identity of the saint.

The lines of underdrawing visible in the infra-red photographs, and, indeed, in many places on the pictures themselves, have the rough, grainy appearance associated with the use of a black drawing 'chalk' (actually a mineral form of graphite). The precise identification of materials used in underdrawing is often difficult due to the small quantities present in a sample, but by comparing the results of elemental analysis of a sample of drawing from the shoulder of the Magdalen with those from a known reference sample it was possible to confirm the use of black 'chalk' [18]. Although under-



Figure 25 *The Virgin and Saint John the Evangelist.* Infra-red detail.

drawing with a black, chalk-like material has been detected on some fifteenth-century paintings (for example, those of Memlinc), it only appears to have come into common use in the early sixteenth century, to some extent displacing drawing with aqueous paints or inks applied with a brush [19]. The colour of the lines representing the underdrawing in Saint Luke's portrait of the Virgin in the picture at Rennes (Fig.16) suggests that van Heemskerck also sometimes used a red chalk. This would explain why some of his works have been reported as having no underdrawing detectable by infra-red methods of examination [20].

Priming or imprimatura

In every cross-section examined, there occurs above the chalk ground and the underdrawing (in the few instances where it is present in the sample) a layer of variable thickness, rich in medium and coloured with a mixture of lead white, charcoal or some form of vegetable black and an iron oxide pigment. This warm, golden colour can be seen beneath the paint layers in very thinly-painted parts of the picture, for example the Virgin's white veil. It was also visible in worn and damaged areas before restoration. The appearance of this layer and its position in the layer structure are reminiscent of the transparent, flesh-coloured priming ('*primuerse!*') over the ground and underdrawing described by Van Mander in his life of Hieronymus Bosch [21]. Thin and lightly pigmented priming layers to reduce the absorbency and to modify the whiteness of the chalk ground have been identified on paintings as early as those of Rogier van der Weyden [22] and continued in use into the seventeenth century, notably in the panel paintings of Rubens [23] and Rembrandt [24].

The amount of pigment present in the priming and the relative proportions of each colour vary considerably from sample to sample (Plates 3b–3d, p.33). A tendency for there to be a greater concentration of pigment and more black and iron oxide in samples from areas in shadow suggests that the priming is not absolutely even and unmodulated but that it has been used to supply some preliminary definition and modelling of the forms and drapery folds. A similar variation in thickness and tone of the priming layer has been noted in samples from van Heemskerck's *Entombment* of 1566 (Delft, Stedelijk Museum 'Het Prinsenhof') [25] and washes of brown undermodelling over a linear brush (?) underdrawing can be seen in the incomplete areas of the *Erythraean Sibyl* (Fig.17). It would be interesting to know whether monochrome brown undermodelling occurs on any of van Heemskerck's works dating from before his visit to Italy. There he would certainly have encountered this practice [26].

The medium of the priming layers which occur on sixteenth- and seventeenth-century panel paintings is generally assumed to be a drying oil [27]. In the case of van Heemskerck's panels it was uncertain whether samples taken for analysis of the medium of the paint layers included any of the priming, so additional staining tests were made on two cross-sections to try to establish the medium of this layer. Surprisingly, while the stain used to identify drying oils produced a clear-cut and unequivocal result on the actual paint layers (see below)

it did not stain the priming at all. Positive staining only occurred with the stain used for identification of collagen deriving from animal-skin glues, so the medium of the priming would appear to be the same glue size which binds the chalk of the ground [28].

Pigments and layer structure

Considering the brilliance and intensity of colour of the inner faces of van Heemskerck's altarpiece wings, the number of pigments identified is small. Striking effects have been achieved more by the admixture or juxtaposition of particular pigments than by the use of an extensive and varied palette.

Only one blue pigment, azurite, is present. This can be seen on large areas of the picture; in the clouds, on the Virgin's mantle and on the Magdalen's shawl (Plate3b, p.33). Generally it has been applied in a single layer mixed with varying amounts of lead white. The deepest shadows of the Virgin's drapery have been reinforced with a glaze of azurite with only a little lead white and a higher proportion of medium. The unusual turquoise colour of all the azurite is due not so much to discoloration, although some may have occurred in the glazes, but to the inclusion of a large amount of orange-brown cuprite as a mineral impurity. Evidently the pigment was selected for its pronounced green hue [29].

According to Van Mander, azurite became expensive and difficult to obtain in the Netherlands during the sixteenth century because of repeated invasions of Hungary (from where it was imported) by the Turks [30]. Therefore it was a surprise to discover that not only had it been used in such generous quantities for the clouds and draperies (and presumably on large areas of the missing central panel as well) but that it also appears, mixed with lead white, as an underpaint for the deep green drapery on the figure of Saint John the Evangelist. In the lightest of the three green samples investigated, the underpaint contains only a few particles of azurite in a matrix of lead white. This suggests that before it was completed with green glazes the undermodelling must have looked strangely like the paint of the blue clouds. The omission of the yellow pigment usually found in underlayers for transparent green colours implies that the drapery was intended to have a particularly cold blue tinge [31], an effect now partly lost due to an increase in warmth caused by the slight browning and discoloration of the superimposed green glazes. The medium of these upper green layers was found to contain some pine resin so they are true 'copper resinate' glazes with the verdigris (or some other copper salt) dissolved in the oleo-resinous medium [32].

Yet more azurite occurs in the maroon-coloured dress of the Virgin (Plate3c, p.33). Here it is mixed with a red lake and lead white, the relative amounts of each pigment varying according to the modelling of the folds. Before the introduction of purple pigments in the nineteenth century, purple and mauve colours could only be achieved by combining red lakes with blue or black pigments. If good quality ultramarine with its slight violet tint is used, a rich, bright colour can be made. However, van Heemskerck's choice of an especially green shade of azurite gives the colour mixture a cold, rather metallic appearance.

By contrast, the white veil of the Virgin seems almost warm in colour, although, of course, this is partly due to the visibility of the priming. The veil and the white surplice of the donor are painted with a simple mixture of lead white and a carbon black, probably charcoal. The same vegetable black has been used for the donor's black cassock, but a sample from the greyish brown fur trimming includes particles of the warmer, brownish bone black mixed with the lead white and carbon black [33]. However, better opportunities to explore van Heemskerck's use of black pigments are provided by the grisaille paintings on the reverses.

The cold greys, blues and greens of the inner faces of the wings are thrown into dramatic contrast by being set against large areas of vibrant reds and pinks. These have been painted using various combinations of vermilion, red lake and a red iron oxide earth pigment. The red-brown background has been underpainted with a mixture of the latter two pigments and then thinly glazed with red lake. Unfortunately, the glaze has developed a cloudy, almost blanched appearance in certain areas (notably to the right of the Magdalen's head). It has also faded. A strip of deeper, more saturated colour can be seen along the left edge of the right wing where the paint must have been protected from light by the frame. In addition a thin section of a red glaze showed a marked loss of colour in the upper part of the layer [34]. Some fading is also likely to have occurred on the pink dress of Saint Mary Magdalene since here the lake is used alone or mixed with lead white. It was not possible to obtain a suitable sample for identification of the dyestuff of the lake by HPLC but when cross-sections which included a layer of the glaze were examined in ultra-violet light the layer fluoresced strongly in the manner of lake deriving from natural madder. Certainly the colour of the lake glazes inclines more towards the warmer, slightly orange shade associated with madder than to the deep, purple reds seen in some insect-derived dyestuffs [35].

All three red pigments occur in samples from the bright red robe worn by Saint John the Evangelist. A cross-section from a mid-tone on his sleeve contains a single opaque layer of vermilion mixed with only a little red lake, but a second sample from a darker area over his calf includes some red iron oxide as well. The fold has then been defined with a glaze of red lake combined with some charcoal to deepen and intensify the shadow of the modelling (Plate 3d, p.33) [36]. The orange-pink stripes on the Magdalen's shawl consist of a layer of red lake, iron oxide and lead white applied over the azurite which provides the background colour of the textile (Plate 3b, p.33). The green stripes have been superimposed in a similar fashion.

There are only small touches of yellow pigment on the panels. A sample from the knot of lilac and yellow shot fabric at the shoulder of Saint John the Evangelist was identified as lead-tin yellow [37]. Lead-tin yellow has also been used over red and yellow ochres to highlight the Magdalen's hair and golden jewellery and ointment jar.

The faces and hands of the two male figures have been painted with simple pigment mixtures. A sample of light-coloured paint from the donor's hand was found to

contain just lead white and the red iron oxide found elsewhere on the pictures. Over this is a highlight with rather more lead white. A cross-section made from darker paint from in front of Saint John's ear is also composed of lead white and iron oxide with the addition of some charcoal. This makes the paint layer difficult to distinguish from the priming with its identical combination of pigments. No samples were taken from the figure of the Magdalen but similar pigments must have been used, perhaps adding some vermilion or red lake for her lips and cheeks. The Virgin, however, has a very different complexion. Her deathly, grey pallor was found to be due to the inclusion of particles of the ubiquitous azurite with the lead white and iron oxide.

The paint medium

To achieve reasonably representative results, samples for analysis of the medium by gas-chromatography-mass-spectrometry are usually taken from both dark and light coloured areas of paint. In the instance of van Heemskerck's panels this produced interesting results. Samples of green paint from each panel, representing the dark colours, were found to contain linseed oil (mixed with a little pine resin as these are 'copper resinate' greens), but samples of white paint from the Virgin's veil and the donor's surplice proved to be walnut oil. Judging from the limited number of reliable medium analysis results available at present, walnut oil is not commonly found on Northern European paintings, while the practice of using linseed oil for the darker colours and the paler, less yellowing walnut oil for lighter areas would appear to be Italian in origin [38]. It is tempting to suggest that van Heemskerck learnt to differentiate between the two drying oils while in Italy and perhaps even brought back a supply of walnut oil to the Netherlands.

Another refinement which can be detected by mass-spectrometry is the possibility of a drying oil having been prepolymerized to some extent by heating or by exposure to sunlight, forming the thicker, more viscous oil known as stand oil. The high octanedioic/decanedioic ester ratios found in the samples of white paint indicate some prepolymerization of the walnut oil [39]. Presumably van Heemskerck chose to use a stand oil because of its greater body; the highlights on the altarpiece wings are often quite dense and solid, even, in some places, with a slight impasto. In this connection it is worth noting that the colours (and especially the white) laid out on the palette held by Saint Luke in the picture at Rennes (Fig.16) have been represented as though the paint were stiff and pastose in consistency.

Method of painting

The impression that van Heemskerck's panels have been fairly rapidly executed with a simple and confident technique is confirmed by the examination of the cross-sections. Only by deliberately taking samples from areas with *pentimenti* would it have been possible to find a paint layer structure of more than two layers. Although the underdrawing has been treated as a very approximate guide to the final placement of the figures, the colour areas have been carefully reserved and overlaps and *pentimenti* are slight, mainly minor adjustments to

outlines: for example, of the clouds, the Magdalen's left elbow and the fall of the Virgin's mantle across her calf.

The unfinished condition of the *Erythraean Sibyl* (Fig.17) suggests that van Heemskerck was in the habit of bringing certain areas, including the flesh painting, to completion while leaving other areas, in this case the drapery, barely started. In addition both versions of *Saint Luke Painting the Virgin* (Figs. 15 and 16) show the faces of the Virgin and Child painted before the rest of the 'pictures' even if here it was clearly necessary for iconographic reasons.

The different coloured draperies have been painted using more than one method of colour modelling. There is no longer a systematic use, as in the fifteenth century, of the technique whereby the modelling is built up with a series of transparent glazes over a base of a relatively light and opaque undercolour which is left unglazed or only thinly glazed to provide the highlights (as opposed to the application of a highlight as a distinct layer). Only the green mantle of Saint John the Evangelist can be said to have been painted in this way. As the underpaint is actually a pale blue even the lightest parts of the folds have had to be thinly glazed. The azurite drapery of the Virgin has been executed with a more direct technique. Most of the modelling has been achieved in a single application of paint by mixing appropriate amounts of lead white with the blue pigment. Only the deepest shadows have been reinforced by a glaze of azurite over the opaque underlayer. Similarly the modelling of the bright red robe of Saint John has been deepened by the use of glazes in the shadows (in this instance intensified by the addition of black to the red lake; Plate 3d, p.33) but the tonal range of the drapery has also been greatly extended by the application, over the base colour, of dense, opaque highlights of virtually pure lead white.

The play between transparent shadows and contrastingly opaque highlights is taken a stage further in the dresses of the Virgin and the Magdalen. Here there is no continuous opaque underlayer. The darkest shades (red lake and azurite in the Virgin, red lake alone in the Magdalen) have been applied directly over the priming giving them a transparency like that of stained glass. Lead white has only been added as the painter worked towards the mid-tones and highlights. Touches of pure lead white have then been dragged across the lightest areas both to heighten the tonal contrast and to create a diaphanous effect to the fabrics (Fig.26 and Plate 3c, p.33).

The huge tonal variation obtained by ranging from deep, glazed shadows to solid white highlights (regardless of the actual colour of the drapery) produces a highly artificial impression. Van Mander criticized van Heemskerck, together with Jan van Scorel, for this lack of naturalism with its hard transition between the tones [40]. To some extent it seems to represent a collision between the Early Netherlandish tradition of modelling from light to dark by the application of glazes, and the more fresco and tempera orientated technique of working from dark to light by admixture of white to the colours as used by many Roman and Florentine painters, in particular Michelangelo and his followers.



Figure 26 *The Virgin and Saint John the Evangelist*. Detail after cleaning, before restoration.



Figure 27 *The Donor and Saint Mary Magdalene*. Detail after cleaning, before restoration.

Another aspect of van Heemskerck's technique which may reflect his experience of Italian painting, this time that of Venice, is his exploitation of the textural properties of oil paint. This is best illustrated in the stiff, white paint of the highlights where the brushmarks are allowed to remain clearly visible (Fig.26) and above all in the beautifully painted fur stole of the donor (Fig.27). Here a convincingly furry texture has been achieved not by the laborious painting in of each individual hair, but by working over the still-soft paint with a dry bristle brush or with some sort of comb-like implement.

The grisailles

Although signs of studio assistance might be expected in the grisaille paintings on the reverses of the wings (Plates 4 and 5, p.40), they have been skilfully executed using similar materials and techniques to those on the inner faces. No underdrawing could be detected by infra-red methods of examination but this may be due to the thickness of the paint layers and to the large amount of black pigment contained in them. The golden brown priming, however, was present in all the samples (Plates 6a and 6b, p.40). The paint of the cold grey stone niches has usually been applied in two layers; an opaque underpaint consisting of lead white and charcoal followed by a darker layer with more black pigment. In the deepest shadows a glaze of vegetable black pigment alone has been used. The medium of these dark shadows is linseed oil with no addition of resin. One sample was

found to contain hopanes indicating the presence of a bituminous material, but this is likely to have originated from the brown pigmentation of the old varnish.

To distinguish them from their niches the imitation stone figures have been painted using warmer shades of grey. They also differ noticeably from one another in colour and were found to contain slightly different combinations of materials. The stone of the bishop on the right wing is still a cool grey but with a slight yellow tinge especially in the mid-tones. The only sample taken for pigment identification came from a black shadow so it just contained charcoal, but it is probable that some bone black or earth pigment has been added to the grey paint. The highlights on this figure are quite thickly applied producing a dense image on the X-radiograph which is inclined to dominate that of the donor and Saint Mary Magdalene. Following the pattern of the inner faces, the binder for the lead white was identified as walnut oil.

The colour of the bishop on the left wing is so much warmer that it could be described as brown rather than grey. Samples showed that this can be accounted for by the inclusion of bone black and red iron oxide with the carbon black and lead white. Even the highlights have a distinctly creamy yellow colour and they were found to differ from the white paint elsewhere on the panels by being bound with linseed oil. In addition this figure is not as thickly and opaquely painted as his counterpart on the other wing and therefore produces a correspondingly fainter image in the X-radiograph.

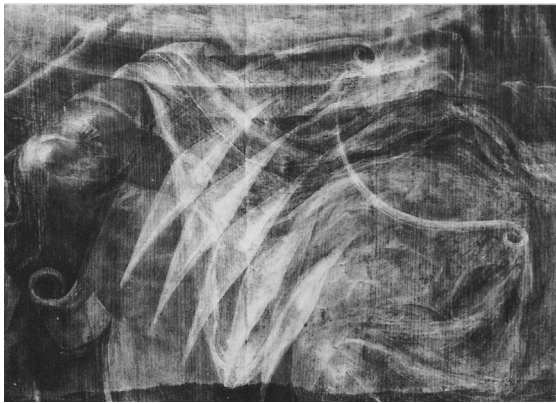


Figure 28 Reverse of left wing (No.6508a). Composite X-radiograph of shield with coat-of-arms.

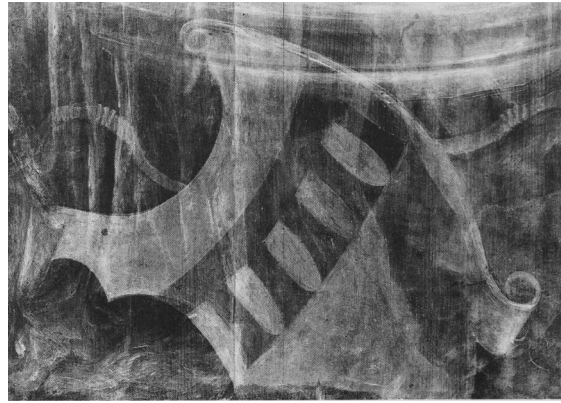


Figure 29 Reverse of right wing (No.6508b). Composite X-radiograph of shield with coat-of-arms.

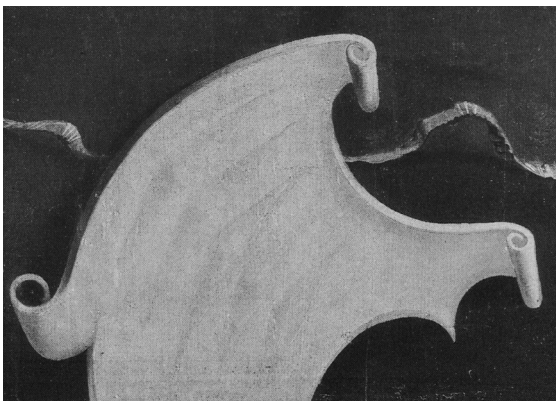


Figure 30 Reverse of left wing. Infra-red detail before removal of overpaint.

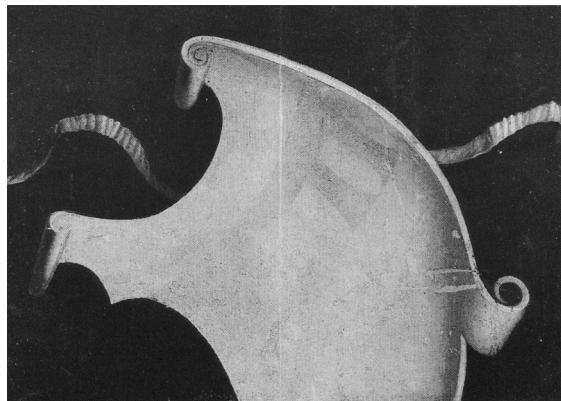


Figure 31 Reverse of right wing. Infra-red detail before removal of overpaint.

The shields and coats-of-arms

To eliminate the problem of reversed images, a second series of X-radiographs was made of the lower sections of the outer faces of the wings (Figs. 28 and 29). As well as showing the hidden coats-of-arms (also visible in infra-red; Figs. 30 and 31), the X-radiographs reveal that van Heemskerck had to alter his design to accommodate the armorial shields. Originally the tromp-l'oeil sculpted figures stood on projecting semi-circular platforms, perhaps supported by a pedestal or column. A cross-section from a point coinciding with this alteration included a thick layer of lead white mixed with only a little black beneath the two layers of grey paint associated with the present recessed niche.

Samples were taken from splits and damages on the shields both to establish the status of the solid red paint layer and to identify the colours of the coats-of-arms in the event of the overpaint not being removed. From the X-radiographs it was evident that the paint of the lozenges across the shield on the left wing contained a good deal of lead white whereas the background was more transparent to X-rays. Conversely the arms on the shield on the other wing appeared as dark against a light, X-ray opaque ground. In each case, cross-sections showed the X-ray opaque parts of the designs to consist, as expected, of two layers of pale grey or white, whereas the more X-ray transparent areas were made up of a very thin layer of red lake mixed with vermilion applied over an equally thin grey underpaint and then glazed with a little red lake (Plates 6a and 6b, p.40). The red lake exhibited identical fluorescence in ultra-violet light to the lake used on the inner faces of the wings. The thinness of the red layers must account for the vermilion making little impression in the X-radiographs.

In more than one sample the vermilion and red lake layers were not present when according to the design they should have been. This was taken as evidence that the paint had been damaged before the application of the presumed overpaint. The overpaint was found to be very different in composition from the other areas of red paint, consisting of a single layer of red iron oxide bound in egg tempera, a medium found nowhere else on the panels. Finally, in one cross-section a thin but definite layer of natural resin varnish could be seen to fluoresce in ultra-violet light between the red iron oxide and the red lake glaze of the original paint.

As a result of these discoveries the decision was taken to remove the overpaint from the coats-of-arms. The areas of grey and white paint were found to be reasonably well-preserved but the thin vermilion and red lake layers proved to be quite badly abraded, exactly as the cross-sections had indicated. In some places on the left wing there was so little original paint left that there was no point in removing all the repaint, especially as the solvents and reagents were in danger of damaging the few surviving fragments. Instead the repaint was integrated with the original colour by applying thin glazes of retouching. This helped to restore some of the three-dimensional quality intended by the artist.

It is hoped that by revealing these coats-of-arms it may be possible to establish the identity of the donor and perhaps to uncover further information about the

Plate 3 Martin van Heemskerck, *The Virgin and Saint John the Evangelist* (No.6508a) and *The Donor and Saint Mary Magdalene* (No.6508b). Photomicrographs of an unmounted fragment (a) and paint cross-sections (b, c, d), photographed in reflected light under the microscope at 320×. Actual magnifications on the printed page shown opposite.

(a) Charcoal underdrawing from squaring-up beneath the red-brown background on the right edge of No.6508a. Photographed from the reverse side with the ground uppermost.

1. Top paint layer; red-brown background.
2. Charcoal underdrawing.
3. Chalk ground.

(b) Red stripe on the Magdalen's shawl.

1. Red lake and iron oxide mixed.
2. Azurite underpaint.
3. Lead white aggregate particle in *imprimatura* layer (ground missing from this sample).

(c) Highlight on the Virgin's maroon dress.

1. Lead white highlight.
2. Maroon paint of the Virgin's dress using a mixture of azurite, red lake and a few particles of lead white.
3. *Imprimatura* consisting of lead white, iron oxide, charcoal and a vegetable black in a yellowish glue medium.
4. Chalk ground.

(d) Deep red of Saint John's robe from the fold over his calf.

1. Red lake glaze containing charcoal.
2. Vermilion underlayer.
3. Chalk ground.

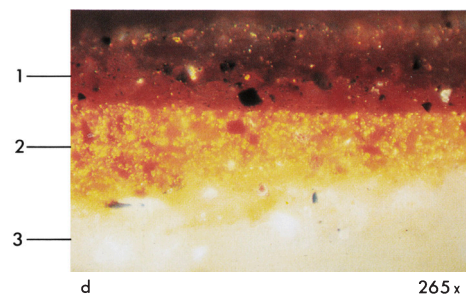
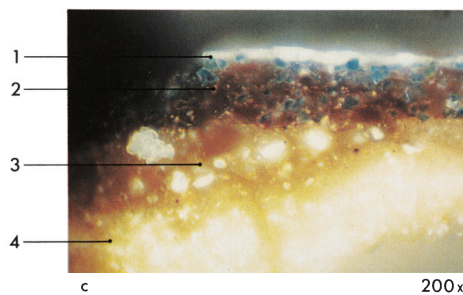
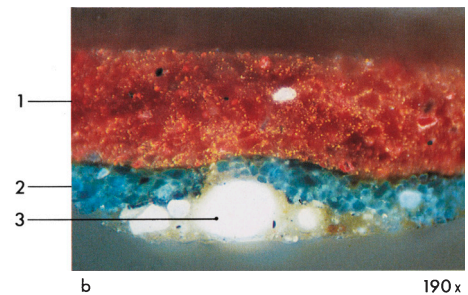
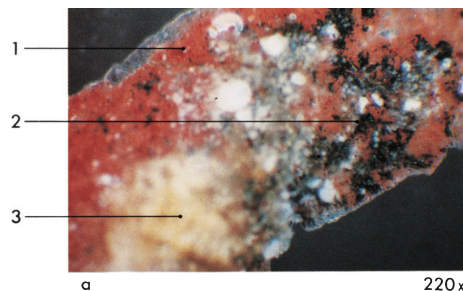
Plate 1 (Right)
Martin van Heemskerck,
The Virgin and Saint John the Evangelist
(No.6508a),
after cleaning and restoration.



Plate 2
(Far right)
Martin van Heemskerck,
The Donor and Saint Mary Magdalene
(No.6508b),
after cleaning and restoration.



Plate 3 Martin van Heemskerck,
paint cross-sections.
Full caption on facing page.



subject and original location of the altarpiece. Despite the loss of the central panel, the National Gallery's acquisitions have repaid detailed scientific study. Technically as well as stylistically they represent fascinating, if somewhat disconcerting, examples of the complex and ever-changing interrelationship between the painting of Northern Europe and that of Italy.

Acknowledgement

We are grateful to Larry Keith for translating the passages from Karel van Mander quoted in the text and in the notes and references.

Notes and references

1. Retouching was carried out with pigments in Paraloid B72. The varnish was Ketone N.
2. See 'Analyses of Paint Media', pp.78–9.
3. This section is based on treatment reports by Ann Stephenson-Wright of the Conservation Department and Brian Eastwood of the Framing Department.
4. See VAN ASPEREN DE BOER, J.R.J., 'A technical study of some paintings by Maarten van Heemskerck', in *Color and Technique in Renaissance Painting, Italy and the North*, conference at Temple University, Philadelphia 1980. A similar system of fitting using wooden dowels is illustrated in NICOLAUS, K., *DuMont's Handbuch der Gemäldekunde: Material, Technik, Pflege* (Cologne 1979), figs. 16 and 17.
5. 'Plastazote', a low-density polyethylene foam was used. For further details see DUNKERTON, J. and SMITH, A., 'Ercole de' Roberti's "The Last Supper"', *National Gallery Technical Bulletin*, **10** (1986), p.35, Note 4.
6. The splits and cracks were secured with 'Cascamite' (urea-formaldehyde) as an adhesive. Moderate pressure was exerted using a series of sash-clamps across the panels, the bars of the clamps cushioned to protect the painted surfaces on the reverses. Areas of flaking paint were treated with sturgeon glue and an electrically-heated spatula.
7. For example: VAN ASPEREN DE BOER, J.R.J. and FILEDT KOK, J.P. (eds.), *Scientific Examination of Early Netherlandish Painting, Nederlands Kunsthistorisch Jaarboek*, **26** (1975); FILEDT KOK, J.P., KLOEK, W.T. and VELDMAN, I.M. (eds.), *Lucas van Leyden Studies, Nederlands Kunsthistorisch Jaarboek*, **29** (1978); and VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., 'Painting Technique and Workshop Practice in Northern Netherlandish Art of the Sixteenth Century', in *Kunst Voor de Beeldenstorm, Noorderlandse Kunst 1525–1580*, Catalogue of the exhibition at the Rijksmuseum, Amsterdam (1986), pp.106–16. The latter is a very useful summary of current knowledge of techniques of the period and includes an extensive bibliography.
8. In addition, while working with Jan van Scorel in 1527–1532, van Heemskerck would obviously have been introduced to the influence of Italian painting.
9. Confirmed by XRD; JCPDS file No.5–586.
10. Glue binding medium for the ground is indicated by staining cross-sections with acid fuchsin.
11. 'Ons moderne Voorders voor henen plochten hun panneelen dicker als wij te witten en schaeftens' alsoo glat als sy wel mochten'; VAN MANDER, K., *Den grondt der edel vry schilder-const*, H. Miedema (ed.) (Utrecht 1973), f.47v., p.253.
12. See VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.107. Also, FARIES, M., 'Les Retables de Jan van Scorel et son Atelier', in *Jan van Scorel d'Utrecht*, Catalogue of the exhibition at the Musée Central, Utrecht (1977), p.23.
13. Charcoal identified using optical microscopy by its characteristically splinter-shaped particles on the underside of an unmounted sample.
14. Den Kongelige Kobberstiksamlung, Statens Museum for Kunst, Copenhagen. This drawing, which also represents the 'Crucifixion', is reproduced in the exhibition catalogue cited in Note 7; see *Catalogue*, p.258, fig.139b.
15. Van Heemskerck could have been introduced to this method of transferring designs in Italy where it seems originally to have been developed by quattrocento Florentine fresco painters (see AMES-LEWIS, F., *Drawing in Early Renaissance Italy*, Yale University Press (New Haven and London 1981), pp.25–6). By the sixteenth century squared drawings were in common use for the transfer of designs to easel paintings. Alternatively, van Heemskerck may have already encountered the technique when working with Jan van Scorel, who of course had himself visited Italy. An underdrawn grid had been detected on van Scorel's earliest known work, the Obervellach Triptych of 1519, which curiously enough is thought to have been painted on his way to Italy. See FARIES, M., 'Underdrawings in the Workshop Production of Jan van Scorel: A Study with Infra-red Reflectography', *Scientific Examination of Early Netherlandish Painting, Nederlands Kunsthistorisch Jaarboek*, **26** (1975), pp.102–104.
16. The tendency for van Heemskerck not to follow closely his drawn designs is apparently so characteristic that in one work recently examined this has been used to divide its execution between van Heemskerck and a member of his workshop. The underdrawing would appear to be by van Heemskerck but the paint layers follow the drawing so precisely that they are thought to have been applied by an assistant. See FOLIE, J. and STEUVE-DE POERCK, M., 'La Dernière Halte du Christ de l'Église Sainte-Waudru à Herentals: un Exemple de Collaboration entre Martin van Heemskerck et un Peintre de son Atelier', *Bulletin de l'Institut Royal du Patrimoine Artistique*, **XVIII** (1980–1), pp.102–12.
17. Collection of Erven I.Q. van Regteren Altena, Amsterdam. The drawing which is reproduced on p.222, fig.103 in the Catalogue cited in Note 7, also includes a study of a classical vase similar in its proportions to the Magdalen's ointment jar.
18. By EDX analysis; the elements aluminium and silicon with smaller amounts of iron, calcium and potassium were found in underdrawing from the Magdalen's shoulder. The same elements have been found by Catherine Metzger in a sample of underdrawing from Jan van Scorel's Marchinnes Polyptych. See VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.114, note 43.

19. See VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.108 and p.110.
20. See VAN ASPEREN DE BOER, J.R.J., *op. cit.* (1980); FOLIE, J. and STEUVE-DE POERCK, M., *op. cit.*, pp.105–106; VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.110; and STEIN, M., ‘En Nederlandsk Bispevielse’, *Kunst og Kultur*, **66** (1983), pp.104–12.
21. VAN MANDER, K., *Het Schilder-Boeck* (Haarlem 1604), f. 216v. See also VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.108.
22. See VAN ASPEREN DE BOER, J.R.J., VAN SCHOUTE, R., GARRIDO, M.C. and CABRERA, J.M., ‘Algunas Cuestiones Técnicas del “Descendimiento de la Cruz” de Roger van der Weyden’, *Boletín del Museo del Prado*, **IV**, 10 (1983), pp.48–9.
23. See PLESTERS, J., ‘“Samson and Delilah”: Rubens and the Art and Craft of Painting on Panel’, *National Gallery Technical Bulletin*, **7** (1983), pp.36–8.
24. See BOMFORD, D., BROWN, C. and ROY, A., *Art in the Making: Rembrandt*, Catalogue of the exhibition at the National Gallery, London (October 1988), entries for Nos. 45, 54, 775 and 850. (Cat. Nos. 9, 11, 3 and 4.)
25. See VAN ASPEREN DE BOER, J.R.J., *op. cit.* (1980); and VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.108.
26. For example: washes of monochrome undermodelling can be seen on unfinished paintings by Leonardo da Vinci and Fra Bartolomeo and have been detected by infra-red reflectography on works by Andrea del Sarto (see BUZZEGOLI, E. and KUNZELMAN, D., ‘Andrea del Sarto in Riflettografia’ in the exhibition catalogue *Andrea del Sarto 1486–1530: Dipinti e Disegni a Firenze* (Florence 1986), p.341) and Pontormo (see VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.97, fig.40).
27. See MIEDEMA, H. and MEIJER, B., ‘The Introduction of Coloured Ground in Painting and its Influence on Stylistic Development, with Particular Respect to Sixteenth-Century Netherlandish Art’, *Storia dell’Arte*, **35** (1979), p.88; and VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.108. For a positive identification of a drying oil in a priming see PLESTERS, J., *op. cit.*, p.36.
28. Sudan black was used first to stain for oil and subsequently acid fuchsin used for glue size. A separate cross-section was stained for egg using amido black, producing a negative result.
29. For another example of azurite containing a high proportion of cuprite selected for its green colour, see DUNKERTON, J. and ROY, A., ‘The Technique and Restoration of Cima’s “The Incredulity of S. Thomas”’, *National Gallery Technical Bulletin*, **10** (1986), p.10.
30. VAN MANDER, K. (1604), *op. cit.*, f.200v. See also HARLEY, R.D., *Artists’ Pigments c.1600–1835*, Butterworths, 2nd ed. (London 1982), p.47. On some later works by van Heemskerck, smalt has been identified. See VAN ASPEREN DE BOER, J.R.J., FARIES, M. and FILEDT KOK, J.P., *op. cit.*, p.109.
31. A second example of this unusual combination of azurite and lead white as an underpaint for green draperies occurs on the figure of Saint Mary Magdalene in Gerard David’s ‘The Deposition’ (No.1078). This drapery is also notably cool in colour.
32. See ‘Analyses of Paint Media’, pp.78–79.
33. Bone black is distinguished from other kinds of carbon black by the presence of calcium and phosphorus, identified using the EDX-mapping facility. By superimposing identified elements on an image of the cross-section, the position of particles of each black pigment in the layer structure can be located.
34. For fuller discussion of the fading of red lakes, see articles on Gainsborough and Lorenzo Monaco in this *Bulletin*, p.51ff. and p.58ff.
35. See KIRBY, J., ‘A Spectrophotometric Method for the Identification of Lake Pigment Dyestuffs’, *National Gallery Technical Bulletin*, **1** (1977), pp.35–44.
36. Although black pigments were commonly combined with red lakes in the seventeenth century (notably in the paintings of Rembrandt; see Note 24) this has not been encountered on earlier Northern European paintings examined at the National Gallery. The only exception is in the deepest red shadows of the kneeling king in Gerard David’s ‘The Adoration of the Kings’ (No.1079), thought to be part of the same altarpiece as the panel cited in Note 31.
37. Lead-tin yellow ‘type I’ identified by X-ray diffraction; JCPDS file No.11–233.
38. For the earliest identified example of this practice see DUNKERTON, J., ROY, A. and SMITH, A., ‘The Unmasking of Tura’s “Allegorical Figure”: A Painting and its Concealed Image’, *National Gallery Technical Bulletin*, **11** (1987), pp.30–1. Italian literary sources of the sixteenth century, including Vasari, often refer to the less yellowing properties of walnut oil. See MACLEHOSE, L.S. (trans.), *Vasari on Technique*, Dover Publications (New York 1960), p.230.
39. See ‘Analyses of Paint Media’, pp.78–79.
40. Van Mander was referring in particular to the Haarlem version of ‘Saint Luke painting the Virgin’ which he described as ‘op Schoorels manier wat te seer cantich afgesneden op den dagh’ [in the manner of Scorel, somewhat too hard-edged (with) isolated highlights]. VAN MANDER, K. (1604), *op. cit.*, f.245v.; for ‘dagh’ in the sense of lights or highlights in seventeenth-century literature, see DE PAUW-DE VEEN, L., ‘De Begrippen “Schilder”, “Schilderij” en “Schilderen” in de Zeventiende Eeuw’ (Brussels 1969). Van Mander objected to these hard-edged highlights because they reduced the sense of volume and recession: ‘Moedt te grijpen, en hoe men schildert, cantighe hooghshels te mijden, vant ten wil niet ronden’ [you must understand, in how one paints, that hard-edged highlights are avoided, because they give no depth]. VAN MANDER, K., *op. cit.*, H. Miedema (ed.), f.48v., p.260.