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FRONT COVER:
Caravaggio, *The Supper at Emmaus*
(detail of Plate 4, p. 42)

PAGE 1:
Jan van Huysum, *Hollyhocks and Other Flowers in a Vase* (NG 1001), 1702–20. Detail.
(See Fig. 4, p. 79)

The Restoration History of Holbein's *Ambassadors*

BY MARTIN WYLD

THIS ISSUE of the *Technical Bulletin* follows the National Gallery's 'Making and Meaning' exhibition on the subject of Holbein's *Ambassadors*.[1] The exhibition has been organised to celebrate the 500th anniversary of Holbein's birth and its catalogue includes a more detailed description than that given below of the technique of *The Ambassadors* and of other panel paintings by Holbein.

The Ambassadors (Plate 1) is a full-length double portrait of two French diplomats, Jean de Dinteville and Georges de Selve, painted in London in 1533.[2] The two sitters are shown on either side of shelves laden with a variety of objects: globes of heaven and earth, astronomical devices, books and musical instruments. The two men stand on a floor inlaid with an elaborate geometrical design. The elongated image of a skull is painted across the lower part of the panel. The background is a green damask curtain, turned back at the top left corner to reveal a silver crucifix at the very edge of the panel. In the lower left corner in the shadowed part of the floor is the artist's signature in Latin: IOANNES HOLBEIN PINGEBAT and the date, 1533 (Fig. 1). The historian Mary Hervey solved many of the mysteries of the picture in her book published in 1900.[3]

The Ambassadors is Holbein's largest surviving entirely autograph panel painting. The panel is made up of ten vertical planks of oak, originally butt-joined with dowels. The oak is of very high quality with a close, even, straight grain. Dendrochronological examination of eight of the planks has established that the latest growth ring present can be dated 1515, and that the oak originates from the Baltic-Polish region. The dimensions of the panel are 207 cm × 209.5 cm, the planks varying in width from 16.1 to 23.8 cm. The planks on either side of the central join are the narrowest, and the widest is now fourth from the left edge, the outermost planks on either side having been trimmed. The top and bottom edges are uncut. The structure of the panel with its later cradle can be seen in the composite X-ray photograph (Fig. 2), which also shows a greater absorption of X-rays in the plank immediately to the left of the centre join, from the level of Dinteville's left sleeve to the lower shelf. This difference in the X-ray image can be accounted for by variations in thickness in the priming layers of the panel rather than in the paint layers themselves.

The ground consists of natural chalk in animal glue, applied in at least two layers. The lower layer is strengthened with fibres, probably of vegetable origin. Over this chalk ground, Holbein laid a cool mid-grey priming composed of lead white tinted with lampblack, bound in a lean medium of linseed oil and vigorously applied. This priming varies in thickness and the brush marks register in the X-ray image (Fig. 4). There is some evidence from cross-sections and infra-red reflectography for underdrawing in a dry black material on the priming layer and of the reinforcement of these lines with black ink or fluid paint. There is no clear indication of pounced dots which would arise from the use of a pricked cartoon. Because of the infra-red absorbing properties of the grey priming and the opacity of the paint layers, only a fraction of the underdrawing which must be present can be detected by infra-red photography or reflectography (Fig. 5).[4] Holbein is known to have used full-sized cartoons for the Whitehall Palace mural and for the Barber Surgeons' group portrait. Many dark lines of paint are present on the surface of *The Ambassadors*, for example in the designs on the scientific instruments, the globes and the tiled floor; these surface lines conceal any underdrawing beneath the paint layers.

The X-ray image shows that a few minor changes were made in the course of painting: the left-hand side of Dinteville's hat was lowered, a small change was made to his right hand and cuff and small modifications to the outline of his costume.

The paint medium has been identified as linseed oil, heat-treated to thicken it and therefore to assist in its drying when mixed with poor-drying pigments. The flesh paints for example make use of plain untreated linseed oil, whereas the red glaze paint on Dinteville's sleeve and his black costume are bound in heat-bodied oil; red lake and the majority of black pigments dry slowly. In the most glazed parts, such as the red sleeve and green curtain, a small amount of pine resin was detected in addition to heat-bodied

linseed oil, presumably to impart a higher gloss to these sections of the painting.

The handling and build-up of the paint layers varies greatly, from the straightforward and direct method used for the main part of the two sitters' costumes, to a more complex technique for the green background curtain. Dinteville's pink satin doublet has a more elaborate paint structure than his dark clothes and employs modelled underlayers containing lead white, vermilion and red lake, with red lake applied thinly in the highlights and thick accumulations of glaze in the shadows. A rather turbid semi-glaze of lake with a little added lead white occurs in the mid-tones. The vermilion is used principally beneath the shadowed and more fiery colours of the sleeve to the left.

The sitters' hair and beards (Figs. 3 and 6), the edges of the fur on their costumes, and the linear designs on the scientific instruments, the mosaic pavement, the globes and the music and script depicted in the books on the shelves are realised in very fine and delicate lines.

The rug, seemingly complex in its treatment of colour, texture, the play of light on the folds, and the depiction of the signs of wear and tear to the fabric, is in fact a fairly simple piece of painting. Holbein used a very dark grey underpaint for the whole of the rug and exploited its optical effect in the final image by applying over it a loosely connected network of small square slabs of red, yellow, blue, white and grey paint to represent the knotted threads. Virtually the whole of the design is constructed in this manner. The use of highlights has been confined to the part of the rug concealing the upper shelf, the ribbing along the border, the painted stitches denoting repair and the plain border hanging at the left. The surface paint makes use of vermilion, red lake, azurite, ochre, white and black to represent the knots.

The inlaid floor in the foreground is also simply painted, consisting of a basic, faintly greenish-grey undercolour over which single layers of warm grey, pink, buff, translucent yellow, greenish-brown and olive-grey paint were applied. There are final impasto flecks of lead-tin yellow, to denote the inlaid serpentine borders, and lines of thin black paint marking out the designs on the tiles.

The background curtain, by contrast, is built up in a complex sequence of layers in order to solve the problem of depicting the hanging folds and the pattern passing from light to shadow as well as to express the varied colour effects and degree of saturation in the green fabric. The repeats of the pattern are clearly painted freehand without the use of a stencil. Holbein

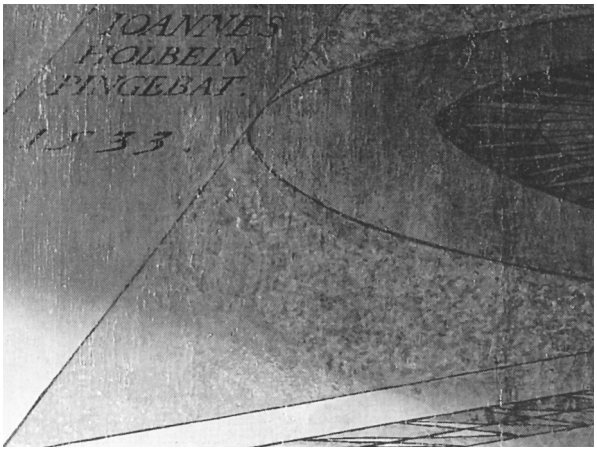

Fig. 1 The signature and date, after cleaning and restoration.

first laid in the basis of the textile design in solid, opaque underpaints containing verdigris mixed with white, and some yellow ochre. The darker paints contain a proportion of black pigment, while in the lighter, more yellow-green underlayers, black is omitted, and lead-tin yellow is used to lighten the colour. There is also a tonal variation in the green undercolour, with certain parts of the pattern created in cool solid tones solely of verdigris and white, which blend into the more yellow-green parts. The upper layers which create the finished transitions of colour, light, shade and depth consist of several thin applications of a green glaze composed of verdigris in oil, containing a proportion of pine resin.

The mid-grey priming present beneath the composition as a whole has little optical effect on the green curtain and the darker parts of the sitters' costumes, but exerts considerable influence on the finished appearance of the heads of Dinteville and De Selve. Although the flesh paint is relatively opaque, particularly that of Dinteville's face, the grey priming has a slight deadening effect in comparison to, for example, other portraits by Holbein painted on light grounds. The main structure of the flesh is worked in two layers: a warm pale-coloured paint, principally white with a little vermilion, and a cooler shadow value containing in addition, red earth pigment, a fine brownish black, and in certain passages, a scumble of finely ground mineral azurite. For some parts of the faces and hands, the light pinkish paint is applied over the darker value; elsewhere the order is reversed. Very thin glaze-like shadows were laid in over these more solid underlayers and the final details of hair, beards, eyebrows and eyelashes were applied at the last stage with a fine brush in fluid browns and blacks.

Plate 1 Hans Holbein the Younger, *The Ambassadors* (NG 1314), after cleaning and restoration.

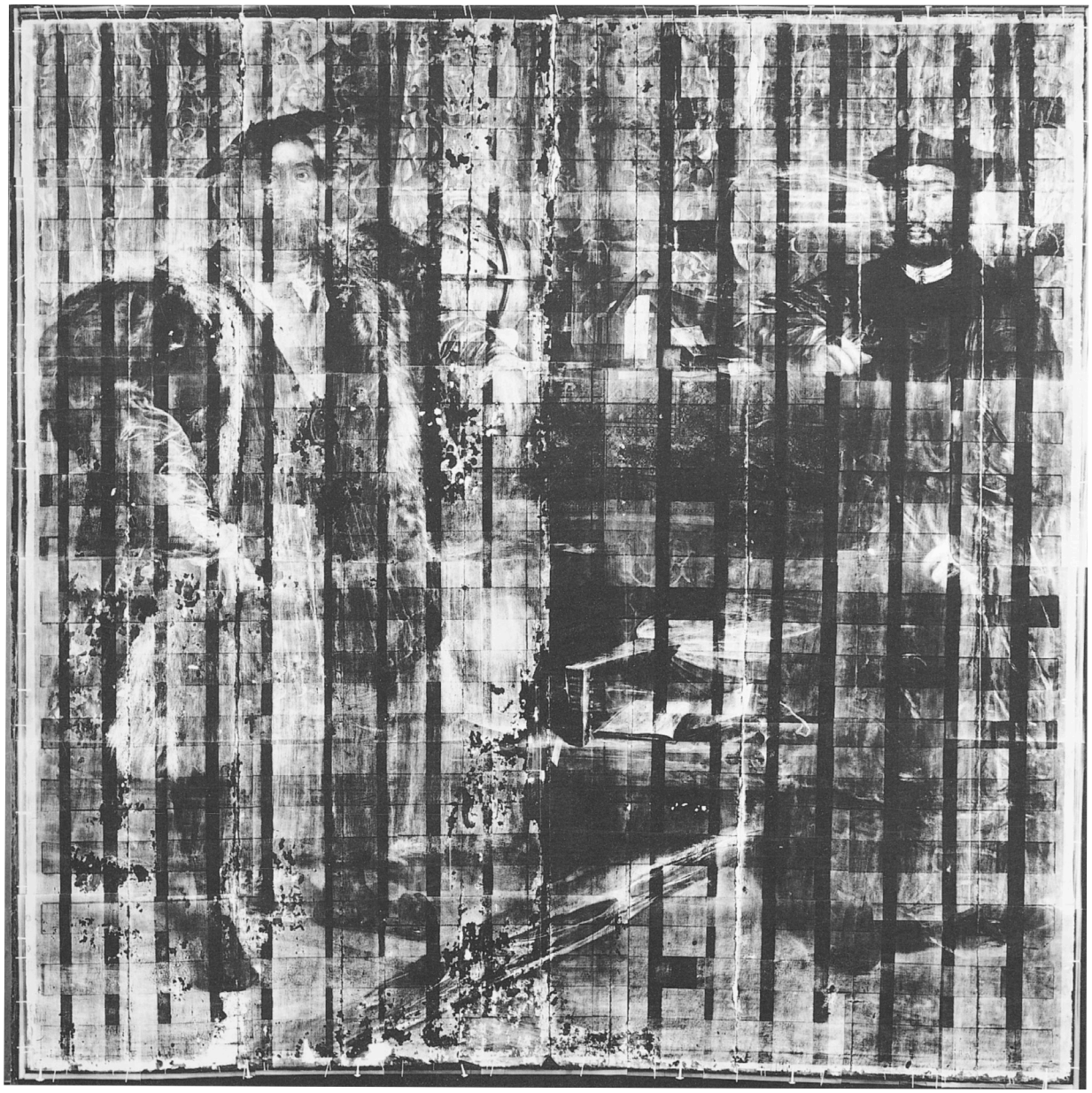

Fig. 2 Composite X-ray of *The Ambassadors*.

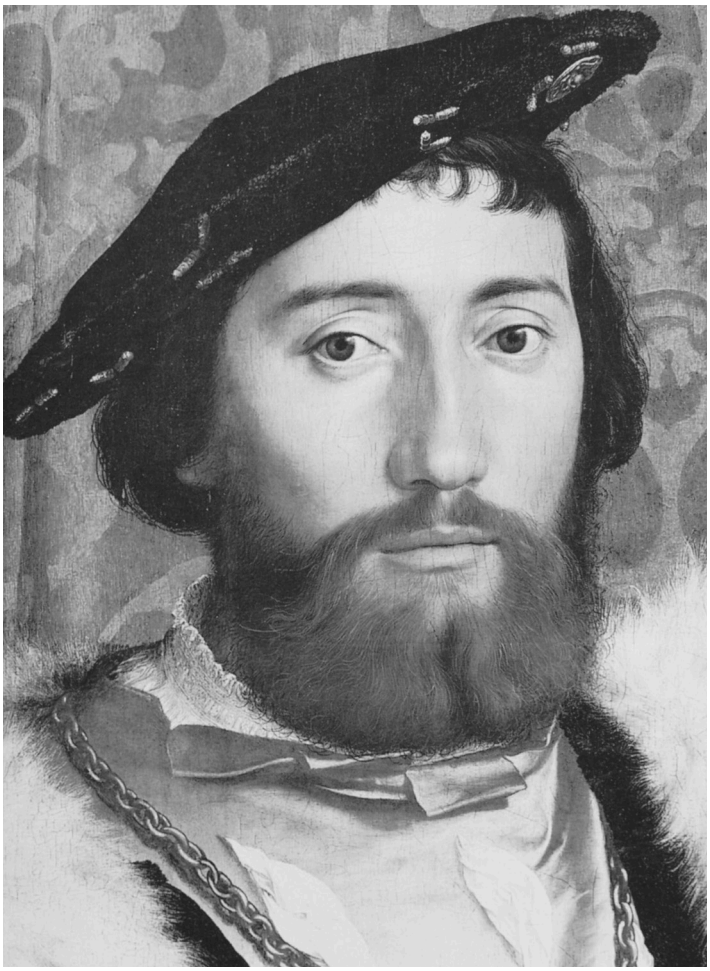

Fig. 3 Dinteville's head, after cleaning and restoration.

Fig. 4 X-ray detail showing the brushstrokes in the grey priming under the black paint of the lute case.

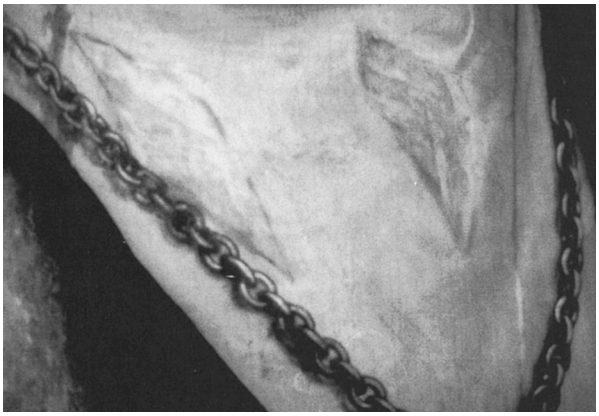

Fig. 5 Infra-red reflectogram showing the drawing of Dinteville's gold chain.

The sitters' costumes, other than Dinteville's pink satin doublet, are constructed from single layers of paint. Dinteville's black tunic is principally a glossy layer of lampblack in oil, containing some pine resin, with the dark greyish highlights at the edges of the pleats formed by working a little lead white into the wet paint. De Selve's fur-lined robe is also a single layer, the pattern constructed from varying proportions of a fine red earth, mixed with lampblack and white, and the different tones blended wet into wet. Some vestiges of a bright red paint, composed of red earth, occur beneath the surface in the lower part of the robe, indicating that initially, perhaps, Holbein may have intended different dress for De Selve.

One of the last stages of painting would have been the decoration using mordant gilding of the chain around Dinteville's neck and the case for his dagger with its hanging tassel. The method is one Holbein appears to have used throughout his career, in which he designed first the structure of the object to be gilded in a chestnut-coloured paint containing earth pigments, then defined the detail over the first layer in a greyish-yellow oil mordant, then applied gold leaf, adding finally with a brush the most minute finishing touches in shell gold.

The History of *The Ambassadors*

The purpose of this article is to provide a detailed account of the recent conservation of *The Ambassadors* and to trace, so far as is possible, the physical history of the painting and the factors which led to its appearance when it was acquired by the Gallery in 1890. The acquisition gave rise to much comment and correspondence in the newspapers. An article in *The Times*, 9 September 1890, included the comment that: 'the condition is faultless, except that the panel is coated with old and perished varnish which should surely be carefully removed.' This, sadly, turned out to be an over-optimistic view.

The following extract from the Gallery's Manuscript Catalogue is the only known record (in the absence of contemporary photographs) of *The*

Ambassadors at that time; it also describes the work carried out by William Morrill on the panel and by William Dyer on the paint surface.

> The picture, when acquired, was in a very unsatisfactory condition. At some former period most of the planks which go to form the whole panel had been separated and rejoined. They were concavely warped in their width, and their edges, curving outwards, had left V-shaped spaces between each two contiguous planks, necessitating a stopping of cement. Partly to conceal this stopping, and partly to cover various abrasions and other injuries, much repainting had been resorted to. The hanging, or curtain, which formed the general background, appeared (as it afterwards proved) to be a piece of coarse restoration from one end to the other. The whole surface of the picture was obscured by coatings of old discoloured varnish. As the picture had to be exhibited at once, no immediate steps could be taken towards improving its condition, or testing how far the restorations might have been justified by actual lesions. But in 1891 the work was examined, and the course to be pursued was determined upon. The first thing necessary was to reduce the cast in the planks. These had to be taken asunder, excepting the two on the right, the joining between which had never given way, and which were not warped. But all had to be planed down at the back, and those which had warped subjected to heavy pressure so as to bring them back to a level. It was found that they had originally been fastened together by small cylindrical oaken dowels, neatly and firmly inserted. A few iron pins were probably of more recent date. The fine-grained oak of the planks was perfectly sound, and nowhere worm-eaten. When all were once more in place, and firmly united, the whole was stoutly parqueted at the back, and the picture itself now presented a perfectly even surface. On the coats of darkened varnish being got rid of, the old restorations showed more distinctly. The removal of these was more tedious than difficult; only the dark heavy green overlying the curtain offered any serious resistance. The removal laid bare the original beautifully painted light green curtain, with its fine XVIth Century pattern, and also revealed a silver crucifix on the extreme left, which had been quite obliterated by the over-painting. As the original curtain had not been damaged but in one or two spots, the motive for so complete an over-painting is not clear, unless it was the notion that a darker background would more strongly throw out the heads, which it was Holbein's design to relieve by opposition of colour alone. The restoration of some few details in the picture which had suffered badly from rude abrasion was, though ill executed, and carried now and then beyond the injured parts, indispensable, and was for the most part confined to the closed book and some objects near it on the lower shelf on the stand, some spots where scaling had occurred on the lower half of the principal figure, and some damages on the tessellated floor. The heads of both figures had escaped both injury and retouching. The whole right half of the picture was intact.
>
> The restoration now required was, therefore, on the whole, not extensive, and demanded only patience and care on the part of the restorer, Mr W. Dyer.

Fig. 6 De Selve's head, after cleaning and restoration.

The image of the picture which is so familiar today is not that which was seen by the Gallery's visitors in 1890. The effect of the overpainting of the curtain and crucifix in a blackish green, the layers of old varnish and restoration, and above all the physical irregularity of the surface due to the concave warping of the planks, their gaping joins 'filled with cement' and covered by retouching, can only be imagined. The treatment described in the Manuscript Catalogue was quite reasonable by the standard of the time. Planing down and cradling warped or splitting panels was a universal practice in England and elsewhere; perfectly

Fig. 7 Detail of the medallion before cleaning, showing the opacity of the varnish and some darkened retouchings. Almost all the craquelure in Dinteville's black costume is in the varnish and retouchings.

Fig. 8 X-ray detail of the medallion before cleaning, showing that no original paint survives. Some highlights in the velvet tunic to the right, hidden by the repaint visible in Fig. 7, can be seen.

Fig. 9 Detail of the medallion after cleaning and restoration.

sound and flat panels were often subjected to the same treatment.

On 7 August 1891, *The Times* reported that:

> Today the great Holbein from Longford Castle will be for the first time visible to the public, having been brought up from the ground floor and placed on a screen in Room VI of the National Gallery. We say 'for the first time' advisedly, for what was visible during the last autumn was the real picture, but the picture disguised by coat upon coat of discoloured varnish, and by the accumulated dirt of many years. As Sir Frederic Burton [Director of the National Gallery] explained in a recent letter, the picture has for some months been in the hands of the cleaner, Mr Dyer, thanks to whose great skill and tender care it has now emerged in all its pristine glory. As is almost always the case with Holbein's work, the colours have stood in the most remarkable way; and, after three centuries and a half, the picture may be said to be finer than ever – a painful example to English painters, who, following their great chief, Sir Joshua, too often paint in a medium that cracks after twenty years, and is hopelessly perished in less than fifty.

The concave warping of the front of the planks, across the grain, can only have been caused by the back of the panel having been exposed to water or damp conditions. The flaking in the lower left half of the picture almost certainly has the same cause, particularly so as much of it occurs along the joins. Paint may have been further loosened by being compressed due to the warping. It is significant that the two right-hand planks had not warped nor been separated before; this is a clear indication that the left part of the panel had been more exposed to damp than the right. Whether this exposure to damp was a sudden or gradual process cannot be determined. The fact that after thinning 'heavy pressure' had to be used to flatten each plank suggests that the exposure to damp had lasted long enough to induce plastic deformation (alteration of the cell structure of the wood), though it can be argued that a flood would have been more likely to affect only part of the panel.

The broad outline of the provenance of *The Ambassadors* is known. It is presumed that Jean de Dinteville, the left-hand sitter, commissioned the double portrait, since it was in the Dinteville family château at Polisy on the borders of Champagne and Burgundy. The château and its contents were inherited by Dinteville's niece, and *The Ambassadors* is known to have been taken to Paris in 1653, and later to have been in southern France before returning to Paris, where it was auctioned in 1787. It was bought by Lebrun, who had sold it into England by 1792, where it was acquired by Buchanan, who sold it to the Earl of Radnor in 1808–9. *The Ambassadors* remained with the Radnors at Longford Castle near Salisbury until its sale to the National Gallery in 1890.

Evidence of several campaigns of filling and restoration in the lower left part of the panel was discovered in the recent cleaning, and this suggests continued flaking over a long period. If the flaking had been instigated by a single flood it might have continued after the first repair, or it may have been due to a constantly damp environment. It has been suggested that the panel was at one time divided into two, and the left half (Jean de Dinteville) exposed to worse conditions than the right. One clue to the dating of the damage and restoration is the reconstruction of the medallion of the Order of St Michael worn by Dinteville. In common with the larger flake losses below it, the ground has here flaked away from the panel and the loss has been filled and the medallion reconstructed (Figs. 7, 8 and 9). Since *The Ambassadors* remained in the possession of Dinteville's niece's descendants until 1787, it may be presumed that this part of the restoration at least must have been done under their guidance. As the identity of the sitters was unknown in England until Mary Hervey's research in the 1890s, it is almost inconceivable that an English restorer could have known what form the medallion should take (Fig. 10).

The damp environment, or flood, which led to the planks warping and the paint and ground flaking away is therefore likely to have occurred before the picture left France in 1787. The green curtain and the crucifix may have been overpainted in either France or England; perhaps this was intended to make the picture more attractive to a potential buyer.

The Recent Treatment

The behaviour of wooden panels, that is, their reaction to changes in temperature and relative humidity, was not well understood in the 1890s and indeed is still the subject of much research. It is now clear that the thinner the panel, the more rapid and pronounced will be its reaction to changes in the environment. The planing of the panel of *The Ambassadors*, plank by plank, to *c.*5 mm, thus exposing a new surface, then forcing the planks flat by 'heavy pressure' and applying a mahogany cradle (Figs. 11 and 12), followed by the exhibition of the picture in a heated gallery in the winter of 1891–2, was almost guaranteed to provoke movement, and so it proved; on 29 January 1892 Morrill wrote to the Director to say: 'I have examined the Holbein panel picture this morning and find the crack is a fresh one altogether, and I have every reason to believe is between the parquets, and the sooner it is attended to the better so as to save it

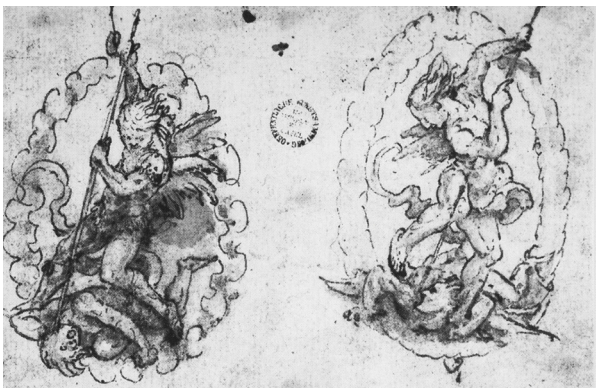

Fig. 10 Hans Holbein the Younger. Drawings of the medallion of the Order of St Michael, Basel, Öffentliche Kunstsammlung.

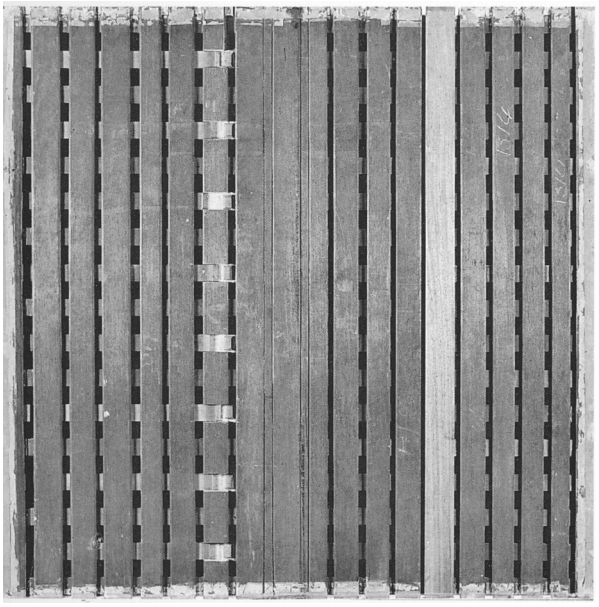

Fig. 11 The back of the panel. The light-coloured vertical cradle member to the right of centre is the replacement of 1940. To the left of centre, alternate horizontal and vertical members were sawn through in 1952.

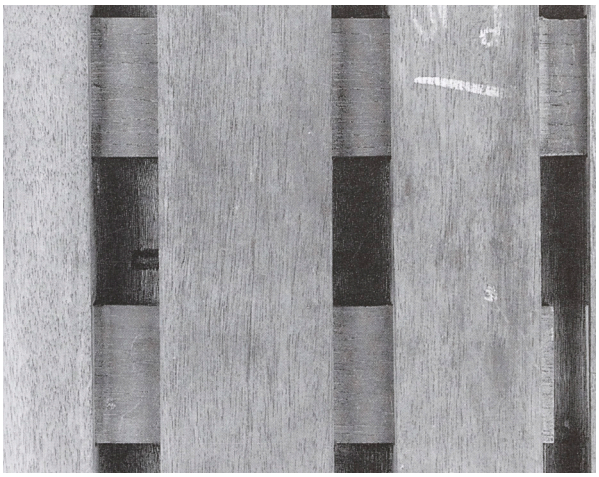

Fig. 12 Detail of the back of the panel. The planed-down surface of the original panel (now *c.* 5 mm thick) can be seen in the gaps between the cradle bars. The remaining part of a dowel channel can be seen either side of the central vertical cradle bar which covers a join in the panel.

Plate 2 *The Ambassadors* before cleaning.

Fig. 13 *The Ambassadors* photographed *c.*1929. There is some surface reflection in the lower part of the figure of De Selve. The deterioration of the varnish and retouchings in the lute case, floor and Dinteville's coat are very evident.

Plate 3 Detail during cleaning, showing a typically yellowed varnish.

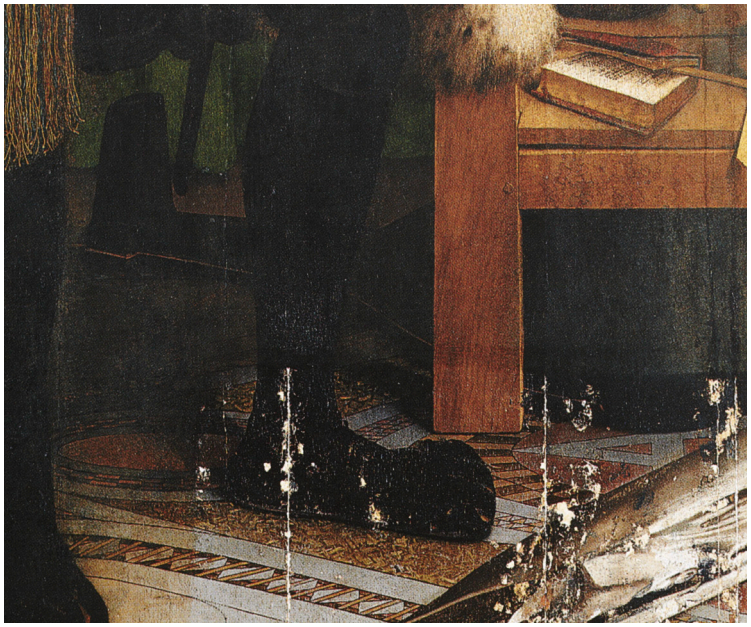

Plate 4 Detail during cleaning, showing the thicker almost opaque varnish in the lower left quarter of the painting.

getting worse, a few days would not hurt, but the earlier attention the better. It would take about 5 days to put it in order.' Several more splits appeared 'at the end of a long frost' in 1895 and further repairs of splits in the panel (generally at the edges of the fixed vertical members) and of blistering paint were necessary in 1929 and 1939.

In 1940, while *The Ambassadors* was being stored in Wales, an existing split at the top of the panel spread along its whole height just to the right of Dinteville's face. The fixed vertical cradle member next to the split was removed, the split joined and a new wider cradle member glued over it (Fig. 11). By 1952, extensive blister laying was necessary and the panel had again split from top to bottom, this time to the right of centre. Soon after this split had been repaired, and the crossbars of the cradle sawn through in places, air-conditioning was installed for the first time in a few galleries. *The Ambassadors* has been exhibited in stable conditions since then and the panel has remained free of further splitting, though it is clearly under some stress.

The earliest photograph of *The Ambassadors* in the Gallery's archives was taken in or shortly before 1929 (Fig. 13). It shows considerable changes in the varnish from the illustration in Mary Hervey's book of 1900. Dinteville's coat, tunic and legs, the lute case, and the shadowed parts of the floor are much less distinct in the later photograph. The thick varnish put on by Dyer in 1891 continued to deteriorate and by the mid-1960s the signature had become almost invisible in Gallery light. The increasing cloudiness and opacity of the varnish and the discoloration of Dyer's retouchings eventually made the lute case invisible and much of Dinteville's costume illegible.

Regular checks on the condition of *The Ambassadors* showed that there was some loose paint and filling in the damaged area of Dinteville's costume, but no danger of immediate flaking. In the early 1990s the Director of the National Gallery suggested a discussion on the possibility of cleaning the picture before the planned exhibition of 1997. An X-ray composite of the picture had been made in 1984 and gave a very clear image of where Holbein's paint was missing (Fig. 2). Close comparison of the X-ray with the picture enabled a very accurate assessment to be made of the old losses in the skull, the left part of the carpet, Dinteville's costume and the floor below, in the lute case and along the central join. The varnish was analysed and small cleaning tests made to test its solubility. Further discussion between the curator and conservation and scientific staff led to the conclusion

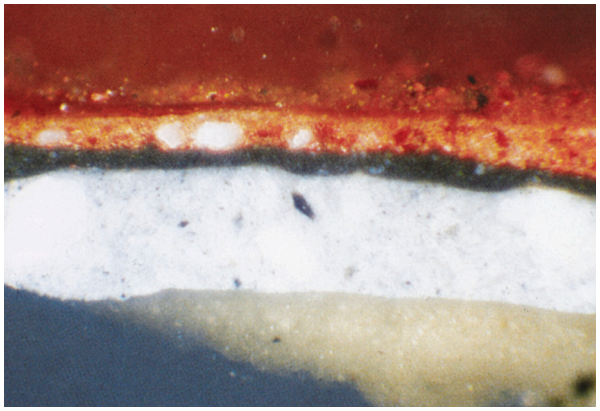

Plate 5 Cross-section from red of carpet, folded edge, below Dinteville's hand, showing brownish-red overpaint and old varnish. The original red contains vermilion and red lake. Underneath is a dark modelling layer composed of lampblack, some white and a copper-containing drier (probably verdigris). The thicker grey priming directly over the chalk ground is a mixture of lampblack and lead white. Original magnification, *c.*275×; actual magnification on the printed page, 220×.

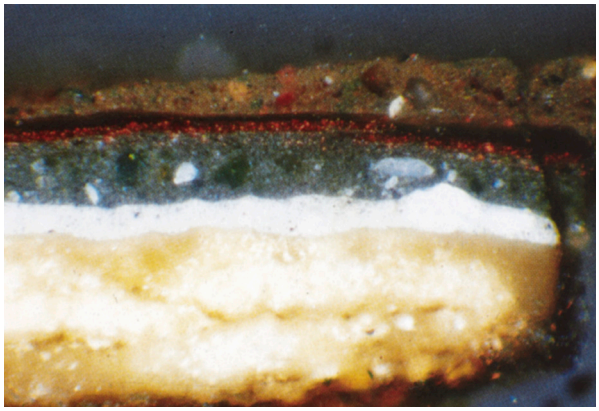

Plate 6 Cross-section from overpainted floor tile behind Dinteville's right foot. Murky brownish-grey overpaint and varnish cover the original more translucent paint of the tile. Original magnification, *c.*275×; actual magnification on the printed page, 220×.

that cleaning was technically feasible, straightforward even, given that the varnish and the majority of the retouchings were only 100 years old. The Director and the Gallery's staff were in agreement that the picture should no longer be displayed with its surface obscured and distorted by the increasingly decayed varnish (Plate 2).

Tests had shown that the varnish could if necessary be removed without disturbing the most recent retouchings, that is, Dyer's work of 1891. At this early stage it was agreed that the old (pre-nineteenth century) reconstruction of the medallion was both skilful and quite possibly valid (Fig. 7), whereas Dyer's reconstruction of the damaged skull was highly speculative and inaccurate and furthermore covered some of Holbein's paint. A detailed report on the condition of *The Ambassadors* and the proposed treatment was submitted to the National Gallery Trustees, who gave their agreement for the removal of the varnish and the majority of the old retouchings, the consolidation of the loose paint, modifications to the cradle if further investigation showed that to be necessary, and finally restoration of the losses in the paint layer.

The cleaning tests were enlarged, various solvent mixtures were tested, and the solvent combination chosen was assessed for the effect it would have on the paint layer during cleaning. This assessment consisted of two types of study of the effects of the cleaning solvents during varnish removal on the paint surface. Detailed analytical comparison using gas-chromatography–mass-spectrometry (GC–MS) was undertaken of the paint-binding medium in samples before cleaning, in adjacent areas cleaned mechanically by careful scraping of the varnish, and in comparable areas where the varnish had been removed with solvents. Secondly, the interior micro-texture of the upper paint films was imaged close to their surfaces at high magnification in the scanning electron microscope (SEM) in samples from uncleaned areas and adjacent areas cleaned with solvents. In each of these studies, for a range of sample sites on the picture, no evidence for degradational changes in the paint film was found, either of damage or extraction of components of the paint medium or of changes in microporosity in the paint layers, as a result of the action of solvents used to remove varnish. The full results of these investigations will be published elsewhere.[5] The varnish was slowly soluble in a mixture of propan-2-ol and white spirit 1:1, and more quickly soluble in a mixture of ethanol, propan-2-ol and white spirit 1:1:3; this mixture was used over most of the surface.

Some cross-sections were taken at this stage to identify the main feature of the layer structure and to clarify the information provided by the X-ray. The first set of 'during cleaning' photographs were taken (Plates 3 and 4) and some more paint samples examined to identify the various layers of old filling and restoration (Plates 5 and 6).

The area around Dinteville's left hand provided a guide to most of the problems that were to arise elsewhere. There was no difficulty in removing the varnish from the fur, the globe, the sleeve, the hand and the carpet. The retouchings along the joins where

Plate 7 Detail of the left edge of Dinteville's coat and the green curtain, where some of the dark repaint which covered the whole curtain and the crucifix until 1891 has survived.

there was no adjacent paint loss, for example through the pink sleeve and the globe, were either removed with the solvent mixture or, if thicker and containing lead white, softened and removed mechanically. These fillings and retouchings dated from 1891.

Other older retouchings on the carpet were also soluble but it became clear that in an earlier campaign of filling, much well-preserved original paint had been covered. The X-radiographs (see Fig. 14) provided an exact guide to where original paint was covered. Some of the fillings could be picked off safely, but some covered original paint and ground that was loose, either as a result of the damp to which the panel had been exposed or because the fillings had shrunk and loosened the adhesion of the ground to the panel. Consolidation with sturgeon's glue was effective in some of the loose areas, allowing the older fillings to be removed safely, and the remainder were left in order to avoid any possible dislodgement of original paint. Where little original paint survived, for example around the upper part of the fold at the left end of the carpet, the old retouchings were not removed once every fragment of original paint had been uncovered, provided that the fillings were securely attached to the panel.

There was a marked contrast between the green curtain above and below the carpet. Below the carpet, the curtain was in good condition, apart from the losses and some slight wearing in the glaze. Above, just to the right of the shepherd's sundial, the paint of the curtain was found to have discoloured and the pattern to be indistinct. All the retouchings in the upper part of the curtain had discoloured and become brown, but in this area the original green paint was also discoloured.

The first part of Dinteville's black costume to be cleaned was the left shoulder, which the X-radiograph showed to be well preserved. The black was thinly painted, mainly in one layer, over the grey priming. Some wearing and many small losses along the various cracks and the grain of the panel were found here, and a horizontal band of blacker, original paint immediately below the fur across the shoulder.

The most difficult part of the surface was the lower left part of Dinteville's coat. The X-radiograph showed large losses in the grey priming (the only component of the layer structure here to absorb X-rays strongly) and the varnish was particularly thick and foggy. It is probable that Dyer in 1891 had repeatedly varnished his retouchings in the black costume, the shadowed parts of the floor and in the lute case; these are the most difficult colours to match and continued reworking and revarnishing led to a greater thickness of varnish.

The varnish over the celestial globe (Plate 3), for example, had discoloured to a yellowish brown, not unusual for a mastic containing walnut oil after exposure to probably rather high light and UV levels from 1890 until the early 1950s, when the Gallery was able to introduce filters. The effect of the varnish, even over the lighter parts of the floor, and the leg of the shelves, was of a turbid greyish fog rather than a normal yellowing (Plate 4). Removal of the varnish and retouchings from the damaged coat revealed severe wearing of the original black paint, where it survived at all, and large areas of filling covered the grey priming. Plate 7 shows some of the coarse repaint which was removed from the green curtain in 1891; this repaint, along the outline of the coat, had been preserved because it had been clumsily covered with filling before that cleaning. Three different generations of filling which Dyer had not attempted to remove were found on the coat, implying flaking over a long period. The repainting of the green curtain must have occurred during this process, since some

of the filling covered the repaint. The remains of a highlight in the satin part of the coat were found, ending in a line *c.*12 cm above and parallel to the bottom edge of the black (the black part of the coat consists of velvet edged, or 'guarded', with satin).

The centre part of Dinteville's tunic from the medallion to the level of the dagger's scabbard was one of the more damaged parts of the paint surface. The surviving original ground was not as fragile as in the lower left part of the coat, and less of Holbein's paint was covered by filling. Some of the varnish was removed from the medallion and the surrounding reconstruction so that its texture would correspond to that of the original paint nearby. This was found to be the roughest area of the surface, with evidence of large blisters having been re-attached to the panel.

The X-ray showed some loss of paint along the lower right edge of the dagger's hilt and in the shadowed fur below. Fillings and rather crude retouchings covered a larger area than the actual losses and their removal revealed the original finger guard and the symmetrical outline of the hilt. The slight (original) misalignment of the hilt and the scabbard had, presumably, led an earlier restorer to alter Holbein's design. As cleaning continued, much of the detail of the sword hilt, the two belts, the highlights of the folds in the velvet tunic and the three rows of cording along its lower edge and up its central divide became clear. Below, the two garters around Dinteville's left knee, the modelling of his calf and the detail of his shoe became more visible. Fillings were picked away from the damaged lower edge of the dagger's hilt, revealing the original outline and the finger guard.

The floor in the lower right corner presented no problems during the removal of varnish and retouchings; very little original paint was covered by fillings. To the right of centre, the inlays and the black lines were, as expected, found to be a little worn but not damaged other than by the panel joins. The paint along the bottom edge was damaged but clearly original. As the X-radiograph showed, some damage was found to the right of the central join and severe damage to the left of it. At this stage no attempt was made to uncover the surviving original paint along the bottom edge and in the left-hand pink triangle, which was very thickly covered with filling and entirely repainted. Most of the surviving original paint of the middle and lower end of the skull was found to be overpainted.

The cleaning of Dinteville's left foot and the bottom of the lute case (Plate 4) showed the very obscuring effect of the foggy varnish over the black paint.

Plate 8 The hymn book before cleaning.

Plate 9 The hymn book after cleaning, before restoration.

Though damage was uncovered, the detail of both the foot and the lute case became visible. As with the black costume above, the grey priming could be seen along the edges of cracks and the ridges of the panel grain, and had clearly been vulnerable in earlier cleanings or blister laying.

A slightly different condition was found in De Selve's robe, where the red/brown paint was thicker than any of the blacks of Dinteville's costume. Fine flaking had occurred all over the gown, but particularly in the shadowed edge below the case of flutes. The grey priming was revealed by this flaking, which was not caused by abrasion of the surface. There seemed to have been a lack of adhesion between the paint of the robe and the grey priming, almost the only defect noted in Holbein's technique. De Selve's gown was examined with the microscope and in raking light to identify any loose paint which might be vulnerable during cleaning, but none was found.

Part of the lower left edge, where the signature is painted over the floor, was cleaned and found to be in good condition apart from the vertical losses from the edges of cracks and some minor damage in the fur edging of Dinteville's coat.

Plate 8 shows the right-hand pages of the hymn book, with some of the musical notation and some of the words (the hymn was written by Luther) covered by old filling. Several letters of the word 'Ewiglich' appeared as the filling was removed (Plate 9).

In the red triangle on the floor below the skull the very thick filling was scraped away to uncover the surviving original paint, including some fragments – discoloured by old surface accretions – of the light strip of floor along the very bottom of the panel. Some original paint at the bottom of the skull and in its shadow was very thickly covered by filling, and was uncovered. The remaining fillings in this area were firmly attached to the panel and of reasonable texture, and were left in place (including part of the reconstructed nose bone) as a base for later reconstruction. The coloured fillings of losses in the shelf and the missing part of the globe (North America) were left in place once the edge of the original paint along the central loss had been found. The same approach was used in the very damaged area around Dinteville's right foot and ankle and in the floor either side and below.

Removal of the varnish and retouchings continued over the remainder of the surface. In places, for example around the edges of losses in the fur of Dinteville's coat, traces of pre-1891 varnish and retouchings were found which were softened with the solvent mixture and easily removed with a scalpel. Many small spots of the repaint which covered the green curtain until 1891 had been left in the hollows of the paint and were removed. Some older retouchings, of a denser brown than the original pattern, were removed from the floor (see Plate 6). The greater part of the surface of the picture was covered only by the varnish applied in 1891 which, although varying in thickness, was easily soluble. Earlier retouchings were not removed provided that they covered no original paint, were of similar texture to the original surface and that the fillings below them were firmly attached to the panel.

The large damage at the left-hand end of the carpet, the loss to the left of the central join including part of the globe and the shelves, the centre of the skull (including the reconstructed nose bone and the floor below), Dinteville's right foot and the floor either side and below, and much of his costume were all left with some old filling and restoration where the criteria listed above were met. Plate 10 shows the picture with cleaning completed.

Consolidation and Structural Work

Some sturgeon-glue consolidation had been necessary during cleaning in order to re-attach fragments of original paint which were stuck to the underside of old fillings but not to the panel. Other areas of loose paint were consolidated after cleaning, mainly in the more damaged left part of the panel near losses. The loose paint responded well to sturgeon's glue which could be introduced through the craquelure without difficulty and was effective in re-attaching the ground to the panel. No separation between paint and ground was found.

Because both sides of the panel had been cut (before 1890) and neither was straight or vertical, stained oak strips *c.*15 mm wide and shaped to match the edges were fixed to the cradle so that they were in plane with the paint surface. This was done so that the new frame could show both side edges of the panel (the crucifix would have been partly covered by conventional framing, since both sides of the panel sloped to the left after being cut). The edges of the panel had been protected by L-section oak strips since 1952, and these were replaced by new oak strips attached to the cradle with slotted screw holes to allow for panel movement.

A slight vertical convex warp of the panel had been noted before cleaning began, and had increased a little when the old edging strips were removed. It was not easy to judge the stresses which were responsible, nor to assess whether they were from the panel itself or from the cradle. The panel was examined on both sides to check that the various splits which had occurred since 1891 were secure. The back of the panel (Fig. 11) showed the repairs. The light-coloured and slightly broader vertical member to the right is the replacement used during the repair at Penrhyn in Wales

Plate 10 *The Ambassadors* after cleaning, before restoration.

where *The Ambassadors* was stored during the war. The solid central part of the cradle dates from the work of 1890/1, and supports the central join and that immediately to its right (as seen from the front). Just to the left of centre can be seen the sawing-through of alternate vertical and horizontal cradle bars to allow the split of 1952 to be glued. Although this part of the panel is clearly structurally weaker than the remainder, it is not subject to any particular pressure and reinforcement was not attempted. The new edging strips, padded at the bottom and attached only to the cradle to allow for panel movement, were judged to be sufficient, together with a permanently stable environment. Fig. 12 shows the remaining part of a dowel channel either side of the vertical cradle member.

Filling and Restoration

It was decided to fill the larger losses before varnishing the picture. The filling was made of equal parts of polyvinylalcohol (Mowiol) 25% in water and polyvinylacetate (Vinamul) 75% in water, and chalk. This mixture was chosen because it is flexible, easy to texture and easily reversible. After filling over the whole surface, using raking and reflected light where necessary, various types and concentrations of varnish

Plate 11 The left end of the carpet before cleaning. Artificial ultramarine (invented in 1828) and some Prussian blue (invented *c.*1704) have been used to reconstruct the pattern of the inner field.

Plate 12 The left end of the carpet after cleaning. The corner of the inner field and the central part of the folded edge are old restoration, not removed, as no original paint survived (see Fig. 14).

were tried. The surface of the paint was rough and absorbent (for Holbein) in places, particularly where the grey priming was only thinly covered, as in Dinteville's costume. It was found that the polycyclohexanone group of varnishes had to be applied very thickly in order to saturate the paint surface sufficiently for retouching to be done.

Dammar of the purest quality available, dissolved in Shellsol E/Petroleum Spirit (aromaticity 37.5%) could be applied in a much thinner layer than polycyclohexanone resin and still saturate the surface rather more evenly. After discussion with the Scientific Department and consideration of lighting, the exclusion of UV, and experience of the many different resins used on other paintings in the collection, it was decided that dammar was the best choice; slight potential yellowing was thought preferable to the greying almost inevitable with polycyclohexanone resins when they are thickly applied.

For paintings of the sixteenth century and later, the National Gallery has usually chosen deceptive retouchings. Restoration has to balance two conflicting requirements: legibility and authenticity. The Gallery's visitors may wish to see, and are perhaps more likely to enjoy, an image uninterrupted by damage, loss, panel joins etc. But a more specialist viewer may want to know what is original paint and what is not. A full photographic record documents the condition of the paint layer.

The fillings were textured where appropriate in imitation of the oak grain or the brushstrokes of the grey priming by applying diluted putty (of the same formula as before) with a small brush and by carving the surface to imitate cracks and fissures in the original paint. The system adopted for retouching was to use watercolour to imitate the grey priming and Paraloid B72 with powder pigments for the main paint layer.

The losses in the floor were reconstructed at the beginning of the restoration because of the relative simplicity of the layer structure and the predictable nature of the pattern repeats. The skull was left for later consideration. The geometrical discrepancies in the floor did not pose serious problems except in the large loss between Dinteville's feet. The decorative borders round all the other circular elements in the floor, although clearly drawn freehand, were consistent in being about three times wider at the sides than at the top and bottom. The surviving parts of the red disc and border between Dinteville's feet could

Plate 13 Detail of the same area after restoration.

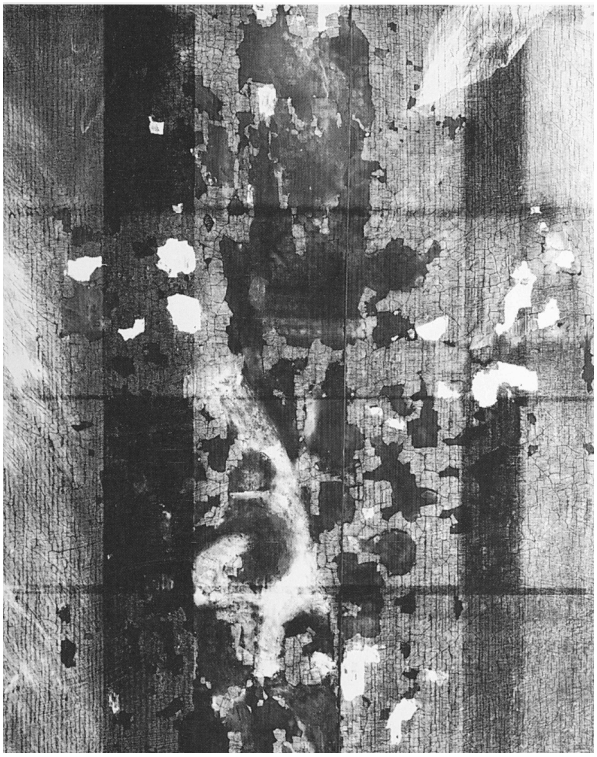

Fig. 14 X-ray detail of the carpet.

not be reconstructed in this way. If the left end of the disc was shortened sufficiently to achieve the same proportions in the border it appeared disturbingly asymmetrical; if symmetrical, the border could not broaden out from the centre as the others did. A compromise was made.

The restoration of the damaged lower left part of Dinteville's coat was guided by a highlight discovered during cleaning *c.*12 cm above the fur. The highlight indicated the edges of the satin part of the cloak, the satin being 'guarded' by black velvet. A similar effect is seen at the shoulders when the fur is abutted by strips of velvet 'guarding'. The remains of the highlight on the satin, lower left, were joined together during retouching to indicate a fold catching the light. The surviving fragments indicated a continuous, though uneven, highlight extending up to the left of the dagger hilt.

The velvet tunic became more legible as the larger losses were touched out. It had become clear during cleaning that the skirt divided, and that the chenille cording or frogging along the bottom edge turned upwards at the central divide. On the left, one of the lines of cording appears from the hidden side *c.*12 cm below the belt. On the right, where the cording is veering to the right just as it is interrupted by the large damage below the waist, it has been suggested that originally a codpiece protruded through the divide in the skirt. This would explain the change in angle of the cording. The reconstruction of the codpiece in the large loss was not seriously considered. Clearly, it would also have been incorrect to continue the cording across the damage. Elsewhere where the highlights on the velvet were interrupted by losses they were continued over the lost area and rejoined. The same approach was adopted with the two belts and with the green-tipped knot of the wider of the two.

The missing part of the globe was reconstructed from a new globe based on the original gores and given to the Gallery; the missing lettering was not replaced. The old reconstruction of the globe handle was altered slightly to correct the perspective and the fall of light; the handle's shadow was left deliberately vague. The closed book (where some old retouching had been left) was reconstructed from the surviving original paint; the eroded letters and numbers were slightly reinforced. The missing letters at the right end of the hymn book were not replaced.

The misalignment between the seventh and eighth planks (the latter having been glued slightly lower

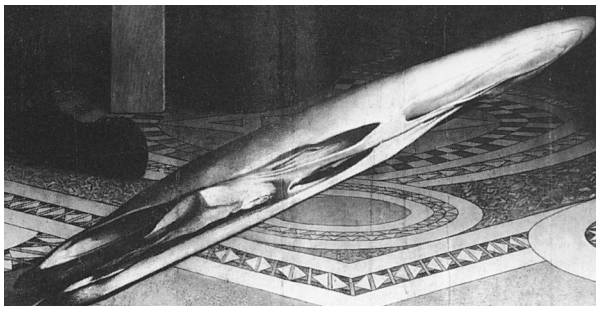

Fig. 15 Detail of the skull before cleaning.

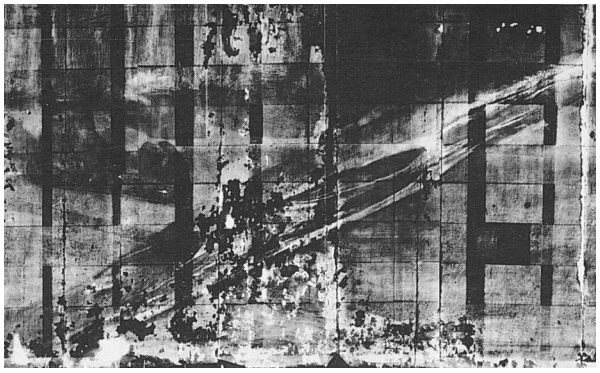

Fig. 16 X-ray detail of the skull.

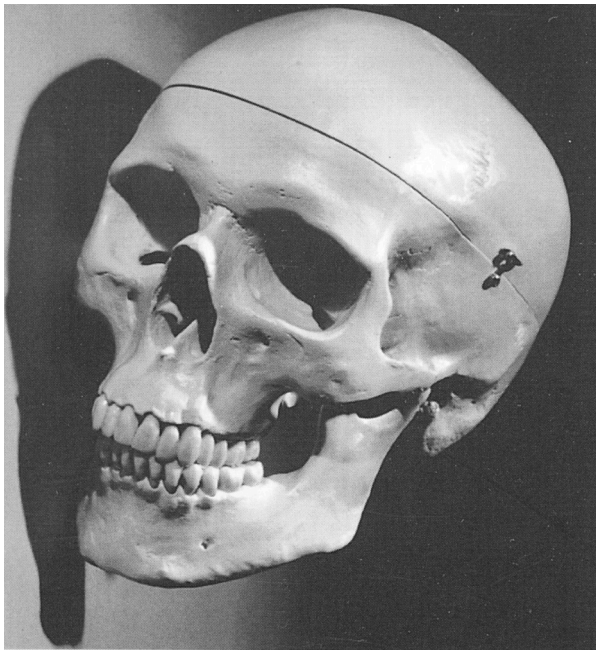

Fig. 17 Anatomical model of a skull photographed under the same lighting as Holbein's skull.

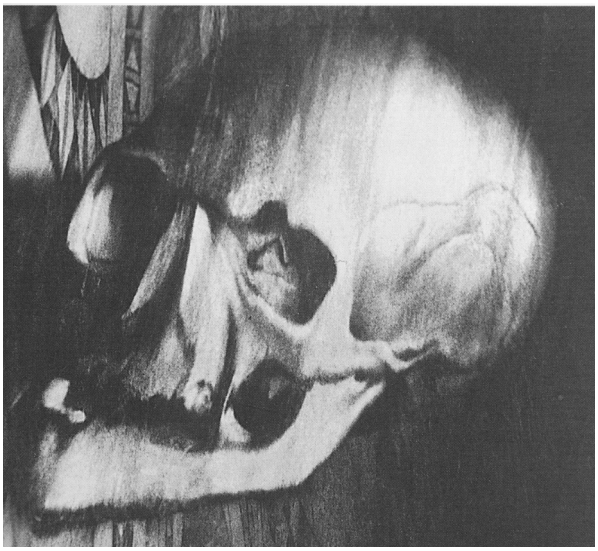

Fig. 19 The skull photographed from the side to correct the distortion, before cleaning.

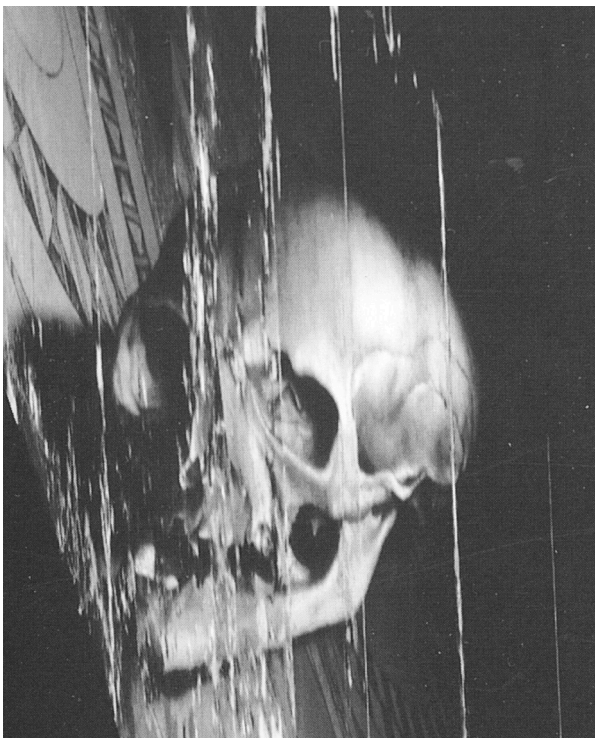

Fig. 20 Digital image of Fig. 18 with perspective distortion applied.

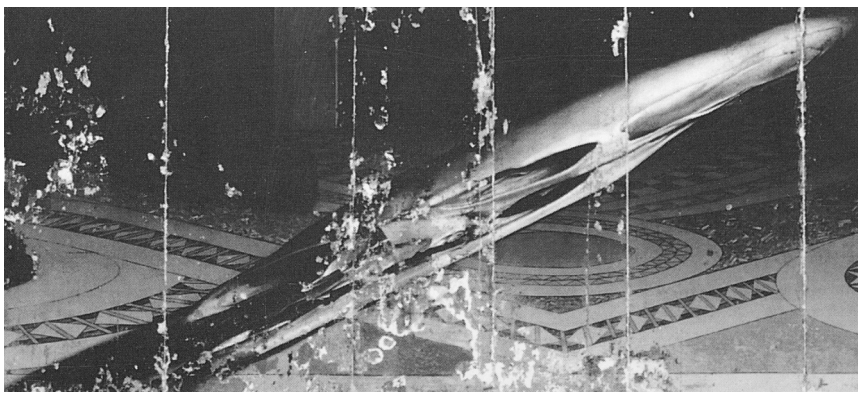

Fig. 18 The skull after cleaning.

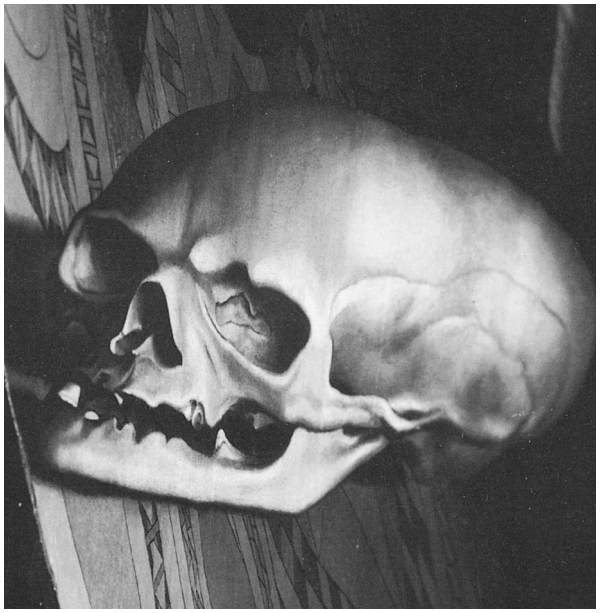

Fig. 21 The reconstruction photographed from the side (at a less oblique angle than Fig. 19) to correct the distortion.

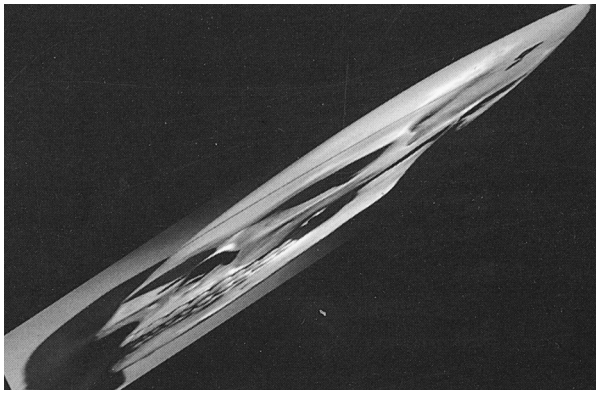

Fig. 22 Perspective transformation of Fig. 17, the inverse of that applied to Fig. 18.

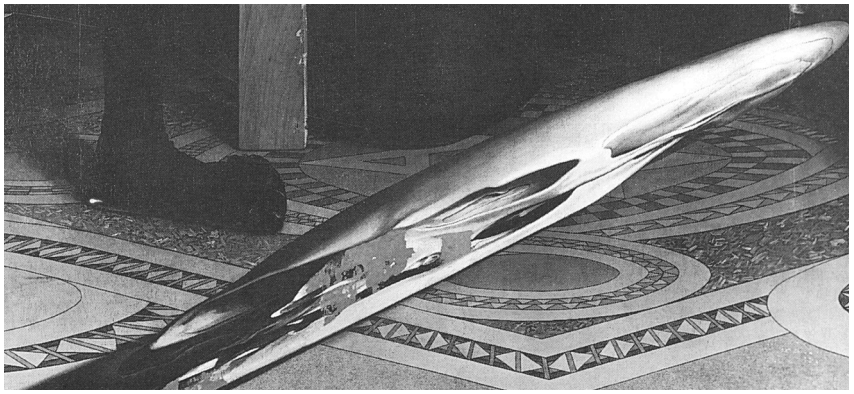

Fig. 23 The skull during restoration, the larger losses having been restored only to the level of Holbein's grey priming.

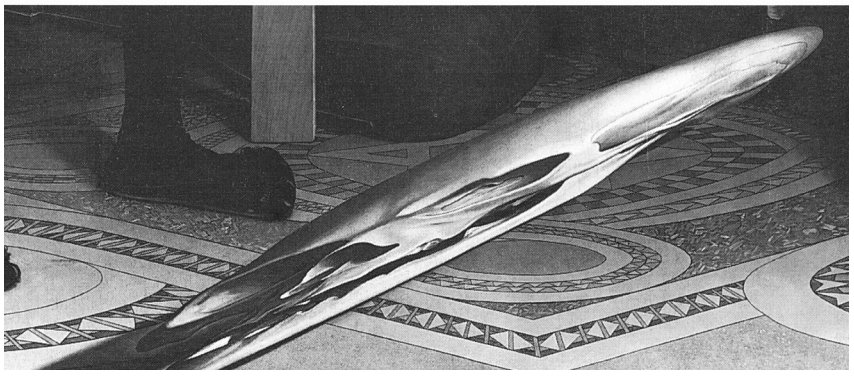

Fig. 24 The final reconstruction.

Fig. 25 *The Ambassadors* in its new frame.

than its original position in 1891) complicated the retouching of the join where it runs through the lute. In addition, vertical warping of these two planks led to the seventh being behind the eighth at the level of the lute and in front of it lower down; careful filling reduced the effect of the uneven panel surface.

The surviving original paint of the green curtain on either side of the central join above the top shelf was discoloured and the pattern to the left both indistinct and seemingly inconsistent. No attempt was made at a full reconstruction.

The losses in the carpet, along the central join, could be logically reconstructed from the evidence of the pattern on either side. To the left, under Dinteville's hand, the pattern had been wrongly reconstructed (partly in artificial ultramarine); there was no red triangle in the corner of the inner field. These details are symmetrical in all known carpets of this date, and it was quite easy to join up the surviving fragments of Holbein's paint to re-establish a symmetrical pattern, which could with confidence be presumed to be the artist's original intention.

The folded-back end of the carpet, which had suffered the largest loss of paint, was more difficult to reconstruct. The previous reconstruction, which was not removed since it covered no original paint, had become brown in colour and did not make proper use of the evidence of the adjacent original paint. It is known that elements of the border patterns may be wider at the end of the carpet than at the side because the individual knots are rectangular rather than square. The subtlety and ingenuity of Holbein's handling clearly cannot be imitated, but the new reconstruction is more closely based on the adjoining original in terms of tone, colour and pattern than was Dyer's of 1891 (Fig. 14, and Plates 11, 12 and 13).

The restoration of the skull was left until the end of the work, and was the subject of much research and debate. The narrow losses along the panel joins at either end of the skull, other small losses, and the floor above and below were retouched; in these areas the original appearance could be deduced with some certainty. The outline of the lower jaw and the cranium were joined together across the larger losses. The remainder of the damage – the end of the lower jaw and part of the nasal aperture and surrounding bone – was left with the grey priming imitated in watercolour pending the progress of research (Fig. 23). Modern imaging techniques seemed to offer the greatest scope for exploring possible reconstructions; sixteenth-century anamorphoses and techniques for distorting and elongating images were also considered.

Following this research, a digital image showing the skull after cleaning was recorded (Fig. 18). A perspective distortion was applied to this image of the skull, and the viewing point was adjusted in three dimensions to determine that at which the anamor-

phosis resolves and the skull assumes its 'normal' appearance (Fig. 20). Using this adjusted image as a guide, an anatomical model of a skull was photographed under the same lighting conditions as the skull in the painting and this photograph (Fig. 17) digitised. The digital image of the modern skull was then subjected to a perspective transformation which was the inverse of that applied to the original image, that is, it uses the same viewing point (Fig. 22). If the effect of the strong lighting necessary for the process (which casts the eye sockets into deeper shadow than in the painted skull) and the presence of a full set of teeth in the modern skull are discounted, there is clearly much to be learnt from the perspective distortion.

Comparison of Figs. 18 and 22 shows that the latter is of great help in establishing the relationship between the left-hand end of the upper and lower jaws and is a good guide to the general shape of, and fall of light on, the nose bone. Further questions then arose: would it be proper to attempt to reconstruct such an important part of Holbein's composition? Would the surviving fragments of paint in the nose bone fit into a reconstruction based on the perspective distortion?

It was decided to tackle the second question first, thus deferring for the time being ethical considerations and the further question of how the Gallery's visitors might react if an image as famous as Holbein's skull were to be displayed incomplete.

Despite the success of the perspective distortion, no reconstruction could hope to re-create Holbein's missing paint with absolute precision – no restoration can in any case aim so high. Furthermore, because of the unique physiognomy of each skull and because the nose bone is the thinnest and most fragile part of the structure, it would be impossible to replicate Holbein's skull exactly. Various skulls and images of skulls had been examined during the restoration; every nose bone was chipped or broken and each had its own particular characteristics.

However, despite these practical and ethical reservations, a tentative reconstruction of the nose bone and the end of the lower jaw was made. It was particularly crucial that the surviving fragments of paint in the nose bone, all of which were brightly lit or in deep shadow, could be integrated into a logical image. These fragments, the original paint surrounding them, and the perspective distortion, together provided enough evidence for a reconstruction which, after many adjustments, was felt to be not too misleading (Figs. 21 and 24). As the ultimate legibility of the skull was presumably a crucial part of Holbein's intentions, it was decided that it was proper in this area of the picture to present it to the public as now reconstructed. The reconstruction can very easily be removed, either down to the level of the grey priming (Fig. 23) or to the stripped state (Fig. 18).

Framing and Display

Little is known of the original display of *The Ambassadors* at Polisy, and nothing of Holbein's own intentions. Not one of Holbein's surviving portraits has retained its original or even a contemporary frame, except for the small roundels with integral mouldings. There is no clear evidence as to the design or finish of any of the lost frames. *The Ambassadors* had been displayed at the National Gallery in an elaborate carved walnut frame made in about 1950, but this frame seemed inappropriate both in design and scale and it was decided to replace it. A simple black oak moulding, based on contemporary Northern European styles and of smaller proportions than the walnut frame, was designed and made by the National Gallery's Framing Department (Fig. 25).[6]

Acknowledgements

Many people have given generously of their time to help and advise during the restoration of *The Ambassadors*. Thanks are due to Claude Blair, James Greaves-Thomas, Peter Klein, John Mills, Lisa Monnas and Margaret Scott, and to my colleagues Paul Ackroyd, Louisa Davey, Susan Foister, Isabella Kokum, Ashok Roy, David Saunders and Raymond White.

Notes and references

1. *Making and Meaning: Holbein's Ambassadors,* Susan Foister, Ashok Roy and Martin Wyld, exh. cat., National Gallery, London 1997.
2. M. Levey, *The German School, National Gallery Catalogues*, London 1959, pp. 46–54.
3. Mary F.S. Hervey, *Holbein's Ambassadors*, London 1900.
4. See Susan Foister, Martin Wyld and Ashok Roy, 'Hans Holbein's *A Lady with a Squirrel and a Starling*', *National Gallery Technical Bulletin*, 15, 1994, pp. 6–19.
5. See A. Roy and R. White, *Studies in Conservation*, forthcoming.
6. The restoration and re-framing of *The Ambassadors* were the subject of a BBC TV production, *Restoring the Ambassadors*, in association with the National Gallery.

A shorter version of this article has been published as an appendix to the catalogue of the exhibition Making and Meaning: Holbein's Ambassadors *(National Gallery, 1997). The description of the technique of* The Ambassadors *at the beginning of this article is partly taken from that catalogue.*