National Gallery Technical Bulletin

Volume 11, 1987

National Gallery Publications
The National Gallery London

National Gallery Publications
Published by order of the Trustees

Scientific Adviser, John Mills
Chief Restorer, Martin Wyld
Editor: Ashok Roy

British Library Cataloguing in Publication Data

National Gallery
National Gallery technical bulletin.—
Volume 11, 1987.
1. Painting — Conservation and restoration — Periodicals
I. Title
751.6'05 ND1640

ISSN 0140–7430

ISBN 0–947645–35–7

Designed by James Shurmer

Printed and bound in Great Britain by
William Clowes Limited, Beccles and London

The Unmasking of Tura's 'Allegorical Figure': A Painting and its Concealed Image

Jill Dunkerton, Ashok Roy and Alistair Smith

Introduction

Alistair Smith

The painting discussed in this article came to the National Gallery with the Layard Bequest in 1916, and accordingly appeared in the 1920 *Catalogue of the Pictures at Trafalgar Square*, where it was described as an *Allegorical Figure* by Cosimo Tura (No.3070; Fig.1 and Plate 1, p.18). This attribution has always been firmly adhered to since the first recorded mention of the painting [1], and is still accepted. Conversely, the subject matter of the painting has given rise to several interpretations, and various suggestions have also been made about its origin and its relationship to other similar paintings. It is possible that the recent treatment and technical examination may make a significant contribution to the resolution of these outstanding problems. Our researches following on the results of the examination and treatment are being greatly aided by the exchange of technical materials relating to the current treatment of the so-called *Caritas* at the Museo Poldi-Pezzoli in Milan (Fig.2).

The compiler of the National Gallery catalogue in 1920 already displayed something of the caution which became characteristic of his successors, for he referred with some scepticism to a statement made by Venturi [2] in 1914 with the words 'Venturi assumes'. Venturi's view was based upon a tradition which related the painting to a series made for the studio of Lionello d'Este at the Castello of Belfiore, just outside Ferrara. He further suggested that the figure represented Spring and that the series, therefore, represented the seasons. The most clearly related painting, Michele Pannonio's panel in Budapest, he described as Autumn (Fig.3).

Most subsequent publications on the paintings took Venturi's 'assumption' as a starting point. In his 1961 edition of the catalogue of the Earlier Italian Schools, for example, Martin Davies [3] still discussed Venturi's assertions at some length, while rejecting Gombosi's interpretation of the figure as *Amphitrite* (Gombosi identified the small figures in the background as Vulcan and Mars, the goddess' husband and lover) [4]. While not proposing any definite identification of the *Allegorical Figure*, and emphasizing the lack of any real documentary connection between the painting and the studio at Belfiore, Davies listed the group of paintings which seemed most likely to have been associated. They are (as described by him):

1. *Allegorical Figure (Spring?)* (London, The National Gallery, No.3070), 116 × 71 cm. By Tura.

2. *Autumn(?)* (Berlin-Dahlem, Staatliche Museen), 115 × 71 cm. 'Wrongly ascribed to Cossa'.

3. *Ceres* (as *Summer?*) (Budapest, Museum of Fine Arts), 136.5 × 82 cm. Signed by Michele Pannonio.

4. *Allegorical Figure* (Florence, Strozzi Collection), 122 × 72 cm.

5. *Allegorical Figure* (Florence, Strozzi Collection), 122 × 72 cm. By the same hand as no.4.

6. *Female Figure* (Budapest, Museum of Fine Arts), 105 × 38.7 cm.

7. *Female Figure* (Budapest, Museum of Fine Arts), 105 × 38.3 cm. By same hand as no.6.

8. *Charity* (Milan, Museo Poldi-Pezzoli), 117 × 80 cm. 'Apparently by a follower of Tura'.

Davies also pointed out that a painter, Angelo del Maccagnino (Angelo da Siena) was active at Ferrara from 1447, and that he worked at Belfiore. Tura, he reminded the reader, was recorded as being active for a room at Belfiore called the 'Studio of Borso d'Este' from 1458 to 1463, a date which is not impossible for the National Gallery *Allegorical Figure*. Indeed, Venturi had accepted it as the 'opera prima conservata da Cosimè' and associated it with his activity at Belfiore around 1460.

The study of the putative series was revitalized by Michael Baxandall in 1965 [5], when he published a letter, written by the humanist Guarino da Verona to Lionello d'Este in 1447. The letter speaks of the Duke's 'truly splendid project of having paintings made of the Muses', and goes on to define Guarino's view on their correct number, names, characters and attributes. For example:

> Melpomene devised song and vocal melody; therefore she must have a book in her hands with musical notation in it.

Baxandall identifies this with no.6. He further equates no.7 with Euterpe ('discoverer of the pipes') and no.2 with Polymnia, a Muse of Agriculture. Pannonio's painting (no.3) he identifies, referring to the inscriptions on the painting, as Thalia who 'discovered one part of architecture', and the Milan *Charity* as Terpsichore — 'let her have boys and girls dancing round her'.

Yet Baxandall does not identify these Muses with the cycle begun by Angelo da Siena for the studio at Belfiore, since the Budapest Melpomene (no.6) does not tally with that seen in the painter's quarters in 1449 by Cyriacus d'Ancona:

> Melpomene wears a golden tunic and a red cloak from the shoulders and plucks a cithera with her left hand, her god-like face turned to her father in Olympus [. . . .] I gazed at the varied brilliant flowers [. . . .]

Baxandall also directs attention to a statement made by

Figure 1 Cosimo Tura, *An Allegorical Figure* (No.3070), panel, 116 × 71.3 cm. Before treatment, with cleaning tests.

Lodovico Carbone, Guarino's pupil, in the 1470s which documents the fact that Angelo painted only two paintings of the series and that the others were produced by Tura, or at least under his direction. Tura, we remember, was documented as working at Belfiore from 1458 to 1463.

Anna K. Eörsi [6] accepted Baxandall's identifications and added to them. The paintings in the Strozzi Collection became, for her, Urania (no.5) and Erato (no.4). The National Gallery painting (no.1) was also Erato. Her conclusion is that the group constitutes remnants of more than one series and that, in all likelihood, some were destined for buildings other than Belfiore.

The question was taken up again in 1978 by Miklos Boskovits [7] who inclined to the view that nos.1, 3, 4, 5 and 8 might go together, since all are of seated figures, have similar viewpoints and are of similar size. Thus, the standing figures (nos.2, 6 and 7) might well have been part of another cycle unconnected with the cycle of the Muses at Belfiore and not identifiable with the paintings completed by Angelo da Siena.

His main contribution is to emphasize the possibility that the Milan painting (no.8) was to a degree overpainted, that it had originally been created by Tura, but converted to a convenient Christian virtue at a later date. The autograph quality of those parts of the painting which have not been overpainted was also affirmed by Mauro Natale [8]. Doubtless the cleaning now underway will be greatly revealing.

Boskovits also speculated on the authorship of the other two paintings which he sees as part of the group of five seated Muses, namely those in the Strozzi Collection (nos.4 and 5). Stressing the lack of documentary evidence, he tentatively attributes them to Angelo del Maccagnino, whom he also posits as the author of nos.2, 6 and 7.

To summarize, while the National Gallery *Allegorical Figure* has been the subject of much speculation, the recent hypothesis is that it represents one of the Muses, that it belongs to a series made for Belfiore, a series executed partially by Angelo del Maccagnino.

As Jill Dunkerton and Ashok Roy write below, there is, as yet, not enough technical evidence available on the other paintings from the putative series to allow one to reconstruct the sequence of the series' execution with any certainty. The findings of the examination of the *Allegorical Figure* show it to be a radical alteration to an earlier painting, which was different in medium (tempera as opposed to oil), composition (the throne in particular was differently shaped) and colour, and probably in subject matter as well. Although there was also a distinct gap in time between the two periods of execution, we are not able to assume that the first painting was made by Angelo del Maccagnino, since the original underdrawing could be in Tura's style. As technical evidence increases in the immediate future, we may well be able to resolve to some extent the outstanding questions.

Figure 2 Tura, *Terpsichore* (formerly 'Caritas'), panel, 117.5 × 81 cm. Before cleaning. Museo Poldi-Pezzoli, Milan.

Figure 3 Michele Pannonio, *Thalia* (formerly 'Ceres'), panel, 136.5 × 82 cm. Museum of Fine Arts, Budapest.

Notes and references

1. Baruffaldi, G., *Vita di Cosimo Tura* (*c.*1706), G. Petrucci (ed.) (Bologna 1836), pp.19 and 37.
2. Venturi, A., 'La Pittura del Quattrocento' in *Storia dell'Arte Italiana*, VII, parte III (Milan 1914), p.521.
3. Davies, M., *The Earlier Italian Schools*, National Gallery Catalogues (London 1961), p.518
Davies gives scant attention to the suggestion that the figure might be Venus. (Ruhmer, E., *Cosimo Tura* (London 1958), p.172.)
4. Gombosi, G., 'A Ferrarese Pupil of Piero della Francesca', *The Burlington Magazine*, **LXII** (1933), p.71.
5. Baxandall, M., 'Guarino, Pisanello and Manuel Chrysoloras', *Journal of the Warburg and Courtauld Institutes*, **XXVIII** (1965), p.183ff.
6. Eörsi, A.K., 'Lo Studiolo di Lionello d'Este', *Acta Historiae Artium*, **XXI** (1975), p.15ff.
This article includes illustrations of all the panels under discussion.
7. Boskovits, M., 'Ferrarese Painting about 1450: Some New Arguments', *The Burlington Magazine*, **CXX** (1978), p.370ff.
8. Natale, M., *Museo Poldi-Pezzoli: Dipinti* (Milan 1982), p.117ff.

Examination and treatment

Jill Dunkerton

Examination before treatment

Before the cleaning of *An Allegorical Figure* (No.3070) (Fig.1 and Plate 1, p.18) was begun, a detailed preliminary examination of the painting was made. This included compiling an extensive photographic record of its condition using both black-and-white and colour photography, together with a complete set of X-radiographs (Fig.4) and a series of infra-red photographs, enlarged to the scale of the painting and made up as a mosaic (Fig.5). Although it immediately became apparent that both the X-radiographs and the infra-red photographs were of great interest as they showed a number of major alterations to the painting which will be described later in this article, at this stage both sets of photographs were primarily intended as aids in determining the condition of the work.

The panel

An Allegorical Figure is painted on a poplar panel [1] approximately 1.5 cm thick. From the design it is obvious that it has been cut at the top, bottom and left edges and probably to a lesser extent at the right edge as well. The two wooden strips painted black along the left and the right edges are not original and have been attached with large nails which can be seen in the X-radiograph (Fig.4). The surviving panel consists of one large vertical plank with a narrow piece of wood, now approximately 2.5 cm wide, glued to the right edge. The glue line is just visible in the X-radiograph and the lower end of the join has opened up slightly. The proximity of the join to the edge suggests that the right side of the panel has indeed been slightly reduced and there may well have been a second join in the missing left-hand section. Clearly the panel was constructed in this manner to avoid any joins and potential splits running through the more important central parts of the picture.

The timber, like that of many poplar panels, contains several flaws. The grain, although roughly vertical, curves and swirls erratically towards the bottom left corner (as seen from behind, Fig.6) and a large knot can be seen in the centre of the panel. At the right edge (as from the back) there is a serious fault where a large branch must have grown out from the main trunk, and a curved split has developed. On the front face of the panel, the panel-maker has cut away a section of the plank over this fault, plugging the gap with a rectangular piece of wood. Movement of the fault from behind has pushed this repair forwards causing the disruption and damage to the paint and ground visible at the upper left edge in the X-radiograph, and on the painting even before cleaning. An L-shaped pattern of elevated cracks in the paint of the throne beneath the figure's right hand coincides with the knot in the back of the panel and indicates a similar repair. Close examination of the X-radiograph reveals yet another repair beneath the patch of sky between the top of the throne and the shell-shaped canopy and to the right of, and roughly parallel to, the branch of cherries. In raking

light this rectangular section can be seen as a slight depression in the surface of the paint and ground [2]. To cover all these faults linen canvas has been glued over the front of the panel before the application of the gesso [3]. The weave of the canvas is quite coarse and its texture is apparent in the X-radiographs and in certain areas on the surface of the painting (Fig. 7).

Apart from the reduction in size, Tura's panel seems to have escaped the worst attentions of past restorers. The chisel marks on the back are probably those of the original panel-maker, although the openness of some of the woodworm channels might suggest that some thinning of the panel has taken place. However it is also possible that the open channels have been caused by the collapse of the wood into areas where the beetles have tunnelled along the grain immediately beneath its surface. The insect damage is most obvious towards the left edge (as seen from the back) of the main plank. This area may consist of sapwood which is particularly prone to attack by woodworm.

Running horizontally across the back of the panel are slightly recessed, lighter bands with no chisel marks which indicate areas where supporting battens have been removed. It can be seen that the sides of these battens were not quite parallel and that they narrowed towards one end. This is a common feature of surviving original battens on fifteenth-century panels. Assuming that the battens were fairly evenly spaced, the fact that the bottom edge now cuts across the lowest batten mark suggests that a larger section has been lost from the bottom of the panel than from the top. The presence of these batten marks and other details of the construction of the panel provide important evidence which should help to determine which of the other paintings thought to be part of the same series can definitely be associated with the National Gallery work, providing, of course, that their supports have also remained in a relatively undisturbed state.

The paint and ground

Despite the obscuring effect of the opaque, almost olive-coloured varnish, it was possible to make a reasonably accurate assessment of the condition of the paint and ground. A striking feature of the surface of the painting was its network of heavy cracks, many with cupped and elevated edges [4]. Along the edges of some of these raised cracks small fragments of paint have chipped off or have been eroded by past cleaning and blister treatments. This form of damage has occurred in several areas of the painting but was most evident in the landscapes on either side of the throne and in the figure's right hand, neck and face. The X-radiograph (Fig.4) confirmed that there were also several larger flake losses from her neck and face, with her throat, mouth and right eye the worst affected, while other parts shown to have suffered from flaking included the upper left-hand dolphin or sea monster, the marble dais and the shadows of the folds of pink drapery.

Unfortunately no photographic aids were needed to detect the largest and most extensive areas of flake loss and the damage could be accounted for by referring to the painting's National Gallery Conservation Record. This describes how, in January 1921, the woodworm-infested panel was sent for fumigation to the 'lethal chamber at the Victoria and Albert Museum. On its return it was discovered that the chloroform fumes had apparently attacked portions of the shell canopy and the draperies (to the left centre of the picture), where verdigris had been used, presumably with a resinous vehicle. These portions were badly blistered and cracked, the paint being left in a fragile condition, made infinitely more intractable by the vaseline with which, as a protection, the whole face of the picture had been covered before submission to the lethal chamber.' Prolonged exposure to chloroform vapour would certainly result in swelling and softening of the varnish and could perhaps have affected any resinous paint, making it swell and expand to such an extent that blisters were formed. Another possible explanation for the outbreak of blisters is suggested by the date of the treatment. Although environmental conditions at the National Gallery would then have been far from ideal, in the course of a journey to the Victoria and Albert Museum in the middle of the winter the painting may have been subjected to a sudden change in temperature and humidity, causing movement of the panel which the paint was unable to accommodate. During the recent treatment of the picture further reasons emerged to explain why these areas of green paint may have been particularly susceptible to blistering.

No immediate attempt was made to secure the blisters and it was not until 1939 that the panel was sent for treatment to one of the firms of commercial restorers used by the National Gallery before the establishment of the Conservation Department [5]. Photographs of the affected areas taken before and after the blister treatment illustrate its consequences (Figs.8 and 9). They show how the brittle flakes of raised paint have collapsed and shattered under the weight of the implement used to reattach the loose paint, resulting in large areas of paint loss. The worst of the damage was then retouched and the varnish 'surface polished', removing the blanching visible in some of the earlier photographs. New blisters were noted in subsequent years but, wisely, were left untreated.

The varnish and previous restoration

The extreme discoloration of the varnish could be attributed partly to oxidation and deterioration, but when a paint sample which included the varnish layers was examined under the microscope, it was discovered that the varnish had been deliberately tinted: blackish and red-brown pigment particles could be seen and the varnish had a hot brown, opaque and almost tarry appearance. This toned varnish may have been applied in 1866 when the Tura was sent by Layard with twenty-one other newly-acquired paintings from the Costabili Collection to the leading Milanese restorer, Giuseppe Molteni [6]. They were probably all in need of attention as the Costabili pictures had been badly neglected. When Otto Mündler inspected the collection in 1858, he recorded in his diary that it 'presents the highest interest and it is therefore deeply to be regretted that so many of these pictures, indeed, with a few exceptions, all of them, are in a state of great neglect, if not completely ruined' [7]. The poor condition of the collection is also reflected

Figure 4 Tura, *An Allegorical Figure*, composite X-radiograph, before treatment.

Figure 5 Composite infra-red photograph, before treatment.


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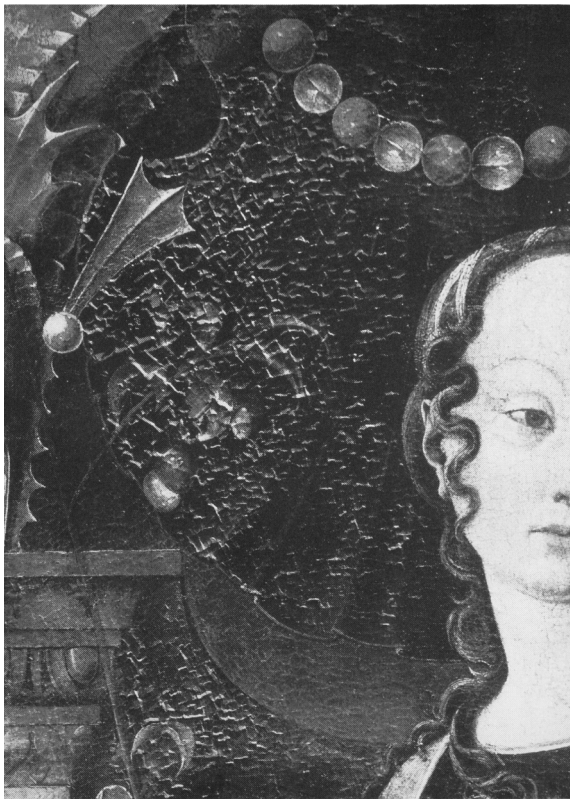


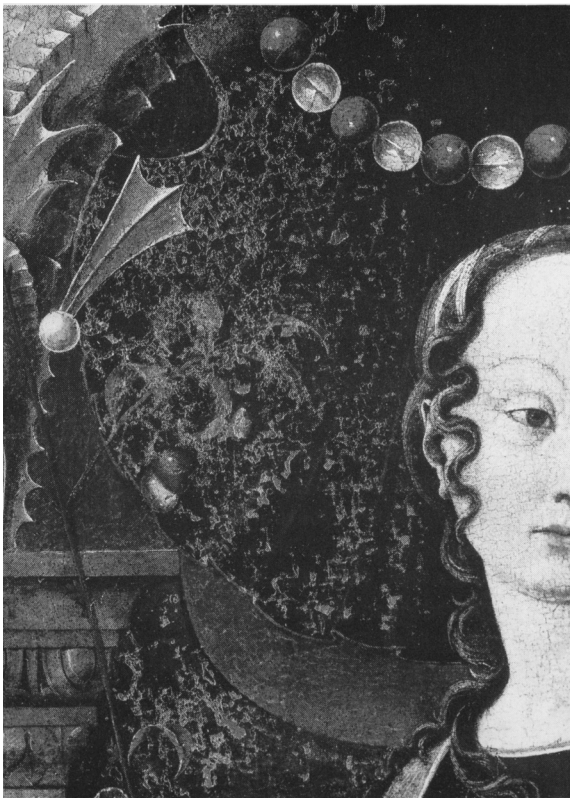


Figure 8 *(Above, left)* Detail showing blisters in the paint after fumigation in 1921.

Figure 9 Detail after blister treatment in 1939.

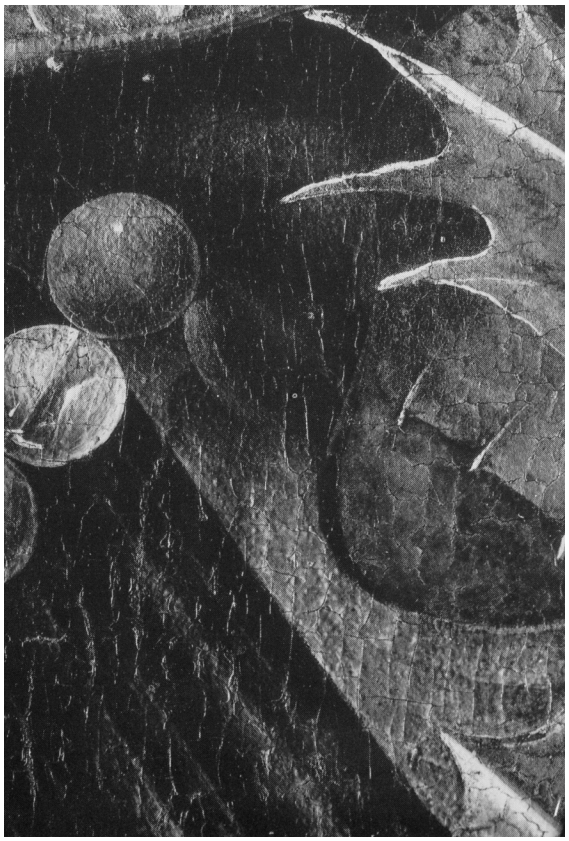


Figure 7 Detail of the shell-shaped canopy in raking light, after cleaning, before restoration.

by Layard's complaint in a letter to Giovanni Morelli that he would have to pay Molteni as much in restoration fees as he had paid for the pictures themselves [8].

Several paintings treated in Molteni's studio are now in the National Gallery and, as they are examined and re-cleaned, his methods and approach to the ethics of restoration are becoming increasingly familiar [9]. The appearance before cleaning of *An Allegorical Figure* was in accord with a probable restoration by Molteni [10]. His own correspondence and other letters which refer to his work frequently mention the artificial patination of pictures with a toned varnish, pigmented with the brown organic pigment, Cassel earth [11]. Cassel earth (more commonly called Van Dyck brown) tends to dissolve partially in oil or varnish [12]. This would produce exactly the effect visible in the varnish sample described above. While some of the retouching over the cracks could be described as generous, Molteni (if it was his work) seems, for once, to have largely resisted the temptation to alter and 'improve' any parts of the picture not to nineteenth-century taste. The only extensively repainted areas were the deep shadows of the pink drapery where the retouching, which had become opaque and turbid, was obviously applied mainly to cover the flake losses, but may also have been intended to reduce the strong modelling and sharp contrast between light and shade of Tura's extraordinary drapery painting.

Figure 6 *(Left)* Back of the panel.

Treatment

Cleaning

While the attitude of Molteni and his contemporaries to the retouching of damaged pictures may not always concur with present-day ethical standards, he does generally seem to have subscribed, whether consciously or otherwise, to the modern practice of reversibility and his restorations are usually reasonably easy to remove. This proved to be the case with the Tura where the varnish and most of the retouchings were readily resoluble in IMS (industrial methylated spirits), leaving none of the dirt and residues of previous varnish layers that are so often found on Early Italian paintings, and suggesting that the picture had been fairly thoroughly cleaned on a previous occasion. The only exception was the pink robe which was covered with a thin, orange-coloured layer, together with smears of thick, crusty black paint over the areas of flaking. The black overpaint, which could be seen in the infra-red photographs (Fig.5), has probably survived from an earlier restoration and to some extent explains the later repainting of this area. It could be removed mechanically with a scalpel and with dilute ammonia, as could old hard retouchings on other parts of the picture. Areas of loose putty, including some crumbling fillings of red lead which show prominently in the X-radiograph (Fig.4), were also removed.

The transformation brought about by removal of the discoloured and toned varnish was, as always, most spectacular in the areas of blue paint, particularly in the careful gradation of the sky (Plate1, p.18) where the bizarre puffs of cloud had been blurred and softened by retouching. Other hitherto obscured features to emerge included the difference in colour between the pink of the figure's robe and that of the marble throne, the gleaming white teeth of the dolphins (Plates 2 and 3, p.18), which had become so discoloured as to have become indistinguishable from the yellow of their bodies, and the veins of pale yellow marbling in the white paint of the dais. Perhaps the most interesting and subtle changes had occurred in the figure's face (Fig.10). The opaque brown varnish made it appear flat and unmodelled, quite unlike the image in the X-radiograph, while the heavy cracks and the clumsy and discoloured retouchings had combined to give her a fierce and rather bad-tempered expression which has inspired descriptions such as 'terribile come un idolo di Borneo' [13] and 'a cold-blooded demon' with a 'mask-like smooth face' [14]. As the varnish and restoration were removed (Plate4, p.18) it became apparent that, despite its damaged condition, the head is in fact strikingly three-dimensional and that the face has a tender if slightly quizzical expression (Fig.11).

Blister and panel treatment

At the edges of the losses uncovered by removal of the old restoration and putty, several layers of paint could often be seen, the colours of the lower layers not necessarily relating to those of the finished painting. This complex layer structure is connected with alterations to the composition to be described later in this article, but poor adhesion between the superimposed paint layers as well as between paint and ground is evidently one of the reasons why the work has suffered from flaking. In the areas of green paint so damaged by the blister treatment of 1939, the flaking was entirely due to the separation of the different paint layers. These areas presented considerable problems during cleaning as much of the surviving paint was still loose, but was impossible to treat while covered with varnish, retouchings and the shattered fragments of crushed paint. The safest way to proceed was to remove as much varnish as possible by applying the solvent with a brush, and then to pick off with a scalpel any displaced fragments of paint adhering to the softened varnish. It was found from paint flakes which included a layer of red from the cherries, that some of these fragments had travelled several centimetres from their original location. They were all far too small to be reattached [15], but it was important to remove them before blister treatment since they otherwise tended to become embedded in the undamaged paint beneath. The remaining blisters and the edges of the flake losses could then be secured using an electrically-heated spatula with sturgeon glue as the adhesive, and the rest of the varnish removed in the normal way by rolling with a

Figure 10
Detail before cleaning.

solvent-soaked swab. Other areas of loose paint and some of the elevated cracks in the ground were also treated during and after cleaning with sturgeon glue.

The panel needed only minor attention. The open end of the join was glued and some of the larger worm channels at the top and bottom edges were plugged with a mixture of wood flour and Paraloid B67. The black-painted wooden strips were left in place as they do not appear to be restricting the panel, and they provide a useful border for handling the picture and to hold it in the frame so that none of the original paint need be covered by the rebate.

Restoration

It can be seen from photographs taken after cleaning and before restoration (Figs. 11 and 13) that although most of the paint losses are relatively small, few areas have escaped without some form of disfiguring damage. The chipped and eroded cracks act like a screen over the image, reducing the legibility of the details and obscuring the design and the spatial relationships between the forms. However, since the heavy craquelure is a characteristic and inescapable effect of age on this and several other paintings by Tura, it was decided that these cracks should not be touched out completely, but should be reduced in width so that they appear more like the visually acceptable cracks in the better preserved parts of the picture, for example, the brocade sleeves and the upper right-hand dolphin. This required retouching of great precision, especially in the landscapes and on the figure's face (Fig.12) where care had to be taken not to distort her expression accidentally as had happened with the previous restoration [16]. The only losses to present any problems were those from the spray of cherries painted over the shell-shaped canopy but it was possible to confirm the correctness of the reconstruction, made initially on the basis of surviving paint fragments, by referring to photographs taken of the painting while it was still in the Layard Collection in Venice [17]. All the retouching was carried out using pigments in Paraloid B72 and imitating, where optically necessary, the complex layer structures revealed by examination of the cross-sections.

The frame in which the painting was displayed was discovered to consist of elements of a fine carved and gilded Venetian-style frame, probably dating from the sixteenth century, but much altered and enlarged to accommodate a glazing door [18]. It has been dismantled and reassembled in its original profile but the nineteenth-century oil-gilding has not been removed as it is extremely hard and tests show that little original gold leaf remains.

Figure 11 *(Left, top)* Detail after cleaning, before restoration.

Figure 12 *(Left, bottom)* Detail after restoration.

Figure 13 Tura, *An Allegorical Figure*, after cleaning, before restoration.

Figure 14 Tura, *An Allegorical Figure*, after cleaning and restoration. The locations of the paint samples illustrated in Plate 6, p.22, are marked *a–p*.

Plate 3 Detail during cleaning.

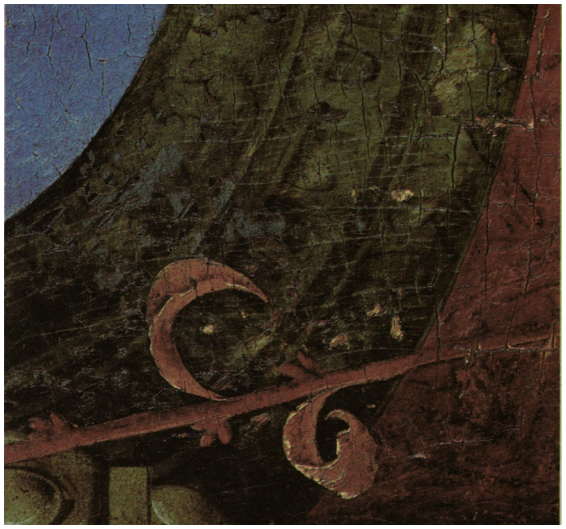


Plate 5 Detail after cleaning, before restoration.

Plate 2 Detail during cleaning.

Plate 4 Detail during cleaning.

Plate 1 (left) Cosimo Tura, *An Allegorical Figure* (No. 3070), after cleaning and restoration.

Technique and alterations to the composition

Jill Dunkerton and Ashok Roy

Pigments, layer structure and interpretation of the X-ray and infra-red images

The wide distribution of the flake losses and other forms of damage revealed by cleaning allowed a good range of paint samples to be taken for examination by microscopical and analytical methods (see Fig.14). This was fortunate as the study of the paint layer structure in cross-section was essential for the interpretation of the X-ray and infra-red images. In addition, quite apart from the alterations, *An Allegorical Figure* is of great technical interest, having been painted during the so-called transitional period when Italian painters were modifying their technique from traditional egg tempera to oil painting methods probably introduced from Northern Europe. It also provided a rare opportunity to investigate in detail a work of the Ferrarese School, whose painters would certainly have been exposed to technical innovations since Ferrara is known to have contained works by Rogier van der Weyden [19].

Ground

Owing to the poor adhesion between the paint and ground the gesso layers are missing from several of the samples mounted as cross-sections. In those cross-sections where the gesso is present, and on areas of the painting where it has been exposed by flaking, it can be seen to be of a rather dirty yellow colour. This is probably partly due to staining by varnish and blister-laying adhesives, but it is mainly caused by the admixture of a high proportion of animal glue with the calcium sulphate. The calcium sulphate occurs in the unburnt dihydrate form ($CaSO_4.2H_2O$) like that of the grounds of other paintings of the Ferrarese and neighbouring Venetian Schools [20]. In certain samples (for example Plates 6e and 6n, p.22) at least four separate layers of gesso are visible, which is surprising in view of the fact that the texture of the canvas glued over the panel is so prominent on the surface of the painting. The layers contain varying amounts of glue with the topmost layer being particularly yellow and rich in medium, perhaps as the result of a separate application of glue size to reduce the porosity of the ground [21].

The large quantity of animal glue in the gesso may be a cause of the heavy craquelure and cupping of the paint and ground, while the glue used to attach the canvas to the panel would provide further hygroscopic material to expand and contract with changes in humidity. Although the presence of the canvas cannot be said to have led to any reduction of cracking (which is sometimes stated to be its purpose) it can be demonstrated to have altered the pattern of the cracks. In the X-radiograph (Fig.4) a light band runs across the picture, level with the figure's breasts and the tails of the middle pair of dolphins. No canvas texture is visible and the fabric on either side has frayed and ragged edges. The area is evidently more opaque to X-rays because of the extra thickness of gesso needed to fill the gap where the pieces of canvas have failed to meet. The ground over this gap has developed a noticeably different craquelure from that of the rest of the painting. The cracks have very elevated edges but are more widely spaced and run in long horizontal lines at right angles to the grain of the wood. Another part of the panel which appears to lack canvas is the right-hand edge where the fabric has barely stretched to cover the join between the planks. Here the edge of the canvas is marked by a series of long vertical cracks through the sky.

Underdrawing

Tura's paintings are very rewarding subjects for infra-red photography and reflectography since bold and clearly visible underdrawing is invariably present [22]. Although a great deal of drawing could be seen in the infra-red photographs taken before cleaning of *An Allegorical Figure*, some of it was obscured by retouchings (especially in the pink robe) so when the cleaning was completed, a second set of infra-red photographs was taken, as well as a complete set of infra-red reflectograms (Figs. 15–18). By using infra-red reflectography it was possible to obtain increased penetration of the paint layers in several areas, including the lighter green draperies [23].

Most of the drawing visible in infra-red occurs on the figure. In her face and left hand it appears as a simple outlining of the features with a firm and confident line which has been followed closely in the application of the paint. A little parallel hatching defines the shadows and modelling of her chin, neck and throat. On her dress a looser drawing technique has been used with the ink or paint applied in broad, fluid strokes. The bodice has been carefully constructed over her torso and breasts which have first been sketched in as though she were to be painted unclothed. Adjustments have been made to the neckline and the outline of her right breast and her waistline has been expanded. No hatching is visible except down the right-hand side of her bodice where it was probably intended to suggest the lacing rather than to indicate any modelling.

Underdrawing of the same style extends into the lower part of the figure but does not coincide with the position of her knees and drapery as they have been painted. It can be seen that originally the knees were placed lower and more to the right and the drapery folds outlined in a rather hesitant fashion without any hatching to establish the structure of the folds and the distribution of light and shade (Figs. 17 and 18). The entire drapery has then been re-drawn in Tura's more usual, confident manner with the knees in their present position and the shadows of the folds established with thick, hatched brushstrokes like those to be seen in his other underdrawings. What the infra-red images cannot show is that this re-drawing of the drapery, and also certain areas of drawing on other parts of the picture, do not lie directly over the ground but, in fact, form an intermediate layer sandwiched between the many paint layers revealed in the cross-sections.

Paint layer structure and alterations to the throne and landscape

The alterations to the painting which are most immediately apparent in the X-radiograph (Figs.4 and 19) are those to the throne. This has been completely redesigned. Originally the back of the throne consisted of a row of tall, narrow columns, rather like the pipes of an organ, but of equal size, and arranged in a more open semicircle than that of the construction now visible. An incised arc marks the curve of the tops of the columns. It shows as white in the X-ray image because the incision has been filled in with subsequent layers of X-ray opaque paint. To the right of the figure a second curve of the same radius has been incised approximately 7 cm below the first arc. It can be seen on the surface of the picture as the gesso and paint have cracked along its line but it is not visible to the left of the figure, even in the X-radiograph, so it may only represent a first, incorrect drawing of the top of the throne. The edges of the columns have also been incised into the gesso; these vertical lines make it possible to detect the continuation of the columns beneath the dense paint of the pink marble of the present throne (Fig.19). The fact that the columns show through the sky and the light green of the upper part of the throne at all suggests that they too have been painted using reasonably X-ray opaque pigments. In the gaps caused by delamination of the upper green layers, areas of yellow paint could be glimpsed (Plate 5, p.18). Two cross-sections made from samples taken through the green confirm that the columns were painted with a golden colour made from lead-tin yellow (hence the visibility in the radiograph), combined with other yellow pigments, including a transparent yellow [24]. In the sample illustrated (Plate 6a, p.22) a few black particles of drawing lie between the yellow and the ground. In both samples the yellow is separated from the green upper layers by a thin and rather broken yellow-brown glaze which probably represents the modelling of the column. Its broken appearance implies that it may have been scraped and abraded before the application of the green paint of the revised throne. The green layers consist of one or, in the case of the sample illustrated, two layers of opaque green, the first a mixture of verdigris, natural malachite and lead white and the second containing the same combination but made warmer in colour by the addition of what appears to be a transparent brown or yellow pigment. The sample also includes a very thin glaze of 'copper resinate' which, as can be seen on the surface of the painting, has discoloured to an orange brown. The green glazes on this part of the picture have only retained their colour where thickly applied in the deepest shadows of the architectural detail.

Yellow paint from a column also occurs in a sample from the pink marble to the right of the figure (Plate 6b, p.22). The pigment mixture is the same as that under the green, but with the proportions of the various yellows adjusted to give a darker shade as the sample point coincides with the shadowed side of the column; similarly, it lies over scattered black particles of underdrawing. However, the yellow paint is separated from the superimposed pink layers by a very thin grey-black layer. Under the microscope this looks rather like the layers of dirt sometimes seen in cross-sections taken to identify areas of repaint. These show restorers' retouchings applied over surface grime on the original paint film. The pink layers of the marble consist of a basic mixture of red lake and white but with the addition of a transparent yellow pigment which gives the colour a warm, brown tint. The cross-section illustrated comes from a light area and therefore only includes two opaque layers with the upper layer containing rather less yellow pigment, but the source of the dyestuff of a sample taken from the rich red glaze applied over these underlayers in an area of shadow to the left of the figure has been identified as lac [25] precipitated onto a substrate of alumina [26].

A puzzling feature of the X-ray image associated with the first throne is an evenly spaced series of blobs or dashes running down the left edge of the outer left column. A sample taken from a damage on the protruberance at the base of the feeler of the dolphin serving as an arm to the throne (Plate 6c, p.22), includes one of these dashes which appears to constitute a simple layer of lead-tin yellow. However, the gesso is missing from the

Figure 15
Infra-red photograph, after cleaning, before restoration.

Figure 16
Infra-red reflectogram mosaic, after restoration. The retouchings show as slightly darker areas here and in Fig. 18.

cross-section so it is possible that there were further paint layers beneath which have scaled off the sample. Over the yellow of this unexplained feature is a solid, brownish black layer. The sample point coincides with a line of drawing visible in the infra-red reflectogram (but not the IR-photographs) so this layer must represent intermediate drawing as part of the revision of the design. Its appearance in cross-section suggests that a brown-black paint has been used rather than an aqueous drawing ink. The dolphin was then painted with a layer of dark yellow containing the same pigments as the columns in the first throne, and modelled with a rich brown semi-glaze composed of a complex mixture of black, red lake, vermilion, iron oxide and lead-tin yellow.

The line of yellow dashes extends into the lower part of the picture, continuing down the column which supported the seat of the throne. A sample taken from the landscape showed that this column was also painted yellow, using the same mixture of pigments found in the other columns. Above the yellow is a layer which might be dirt but is more probably a thin layer of drawing. The green of the landscape above comprises a single layer of verdigris mixed with lead-tin yellow but the sample comes from an area with considerable damage to the upper paint layers, so further glazes may once have been present. Many more layers appear in a sample from the shadow of the cave in the landscape on the opposite side (Plate 6d, p.22). Over the ground lies a substantial layer of green pigment with the globular particle form characteristic of artificial malachite [27]. In the centre of the cross-section there is a V-shaped break in this layer and in the upper layer of the gesso. The gap has been filled in with paint from the next layer above which is quite different in composition, containing a mixture of malachite, this time of the natural mineral form, verdigris, lead-tin yellow and lead white. This suggests that a scratch or groove was made in the artificial malachite layer, either accidently or perhaps deliberately to abrade the paint surface before applying the subsequent paint layers. There is also a hint of dirt or drawing between the two layers. The second layer, which must represent the first layer of the revised composition, has then been covered with a darker green, based on verdigris mixed with lead-tin yellow and lead white and therefore identical to that of the landscape on the left. The pinkish brown of the rocks has been superimposed over the green layers using a slightly lighter and pinker version of the complex mixture of black, red lake, vermilion, iron oxide and lead-tin yellow found on the brown parts of the dolphins. Finally, to achieve the rich dark brown of the deepest shadows a further two layers have been applied: the first, rather surprisingly, consists of a semi-glaze of verdigris and the second of a true, fully transparent glaze of red lake. These green and red glazes, which are best distinguished in the cross-section when it is viewed in transmitted light, appear to have been used to model much of the detail of the landscape [28].

The only part of the throne to have escaped major alteration is the white marble dais on which it is placed, but even here a number of small *pentimenti* can be identified. Some of the straight lines have been incised into the gesso. They run under the overlapping drapery folds, so the position of the dais must have been estabished before these folds were drawn in. However, the grey paint above the ledge of the platform does not follow any incisions and has been added as an afterthought over dark red paint which is apparently the same as that of the sides of the throne. At either end of the platform, green paint can be seen at the edges of flake losses so it may originally have been slightly narrower, while the X-radiograph shows that the left side of the protruding edge has been reduced leaving the drapery fold suspended, as it were, in mid air. A sample taken from just below this *pentimento* has a simple paint layer structure. Over some underdrawing is a layer of a pale pinkish white which is also visible on areas of the surface of the picture. To obtain a marbled effect it has been partially covered with streaks of the pure lead white visible in the cross-section, and then veined with an opaque yellow pigment which, although not sampled, must be lead-tin yellow. A sample from the shadowed underside of the ledge (Plate 6e, p.22) includes a thick layer of drawing which, despite lying directly over the ground, looks similar to that seen as an intermediate layer in other cross-sections. The paint layers consist of a warm brown-grey which has the appearance of a mixture of bone black and lead white, followed by a thin

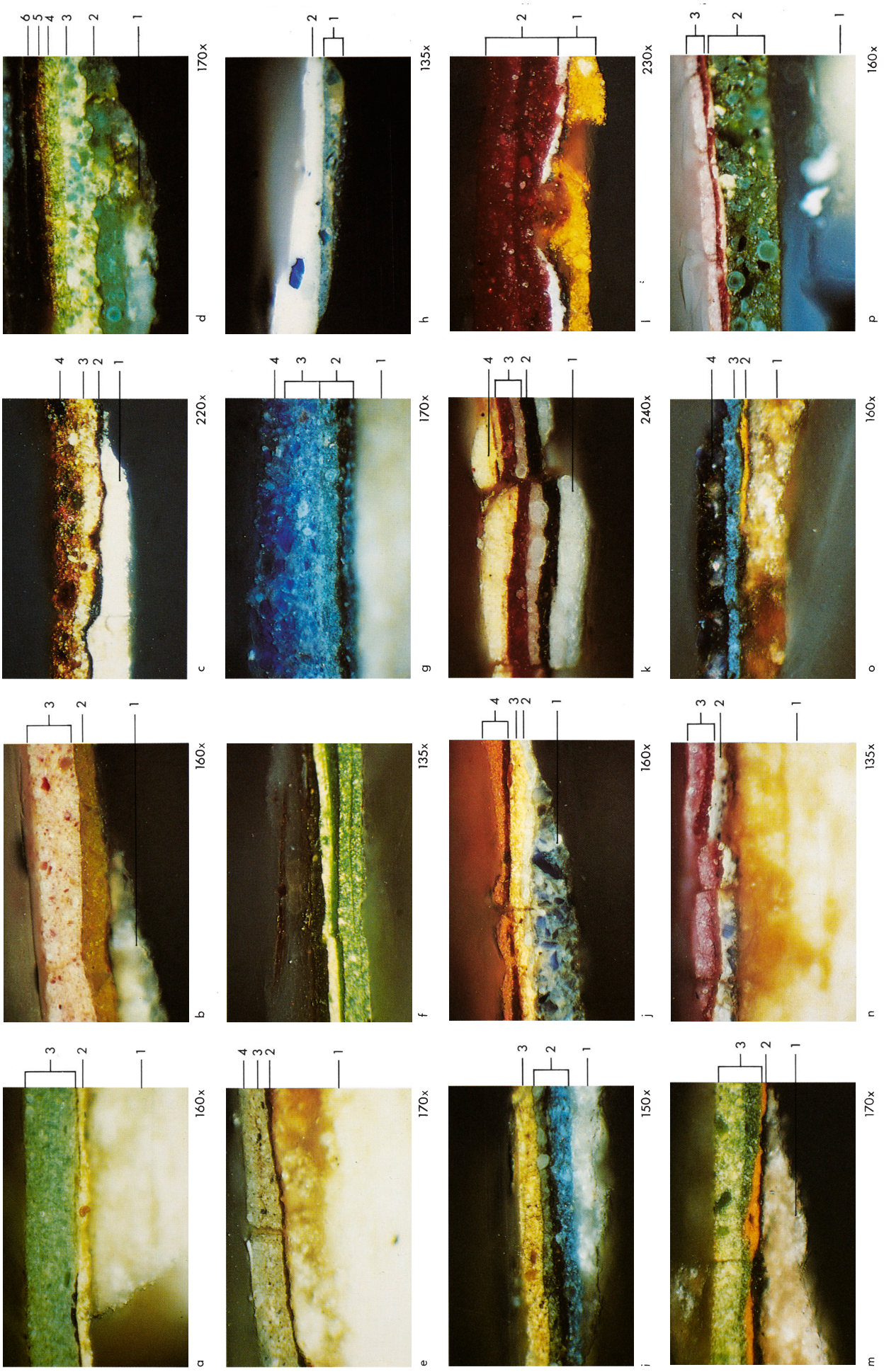


Plate 6 Cosimo Tura, *An Allegorical Figure* (No. 3070). Full caption on facing page.

Plate 6 Cosimo Tura, *An Allegorical Figure* (No. 3070). Photomicrographs of paint cross-sections, photographed in reflected light under the microscope at 220× (*a*, *b*, *d–j*, *m–p*) and 320× (*c*, *k*, *l*). Actual magnifications on the printed page are shown opposite. Sample locations are given in Fig. 14, p.17.

(a) Green of top of throne, l.h.s.

1. Gesso ground with a few particles of drawing at the surface.
2. Yellow of concealed column comprising lead-tin yellow 'type I' with a little yellow earth and probably a transparent yellow pigment. There is a thin discontinuous brownish glaze and also some intermediate drawing at the surface of this layer.
3. Two layers of opaque green consisting of verdigris and natural malachite combined with lead white. The upper layer contains a proportion of transparent yellow pigment. There are traces of a final discoloured 'copper resinate' glaze.

(b) Pink marbling of throne, r.h.s.

1. Gesso ground with underdrawing.
2. Yellow-brown of concealed column, as layer 2 in (*a*), but with a higher proportion of earth pigment and transparent yellow. Between this and the next layer is what appears to be a thin film of surface dirt.
3. Two layers of opaque pink consisting of red lake pigment and a transparent yellow in a matrix of lead white; there is a greater proportion of the yellow in the lower layer.

(c) Dark brown cheek of dolphin, l.h.s.

(Gesso ground missing from sample.)

1. Lead-tin yellow associated with first throne.
2. Thick line of intermediate drawing.
3. Yellow undermodelling of dolphin: mainly lead-tin yellow + transparent yellow.
4. Brown semi-transparent modelling: mixture of black, red lake, vermilion, iron oxide and lead-tin yellow.

(d) Shadow of interior of cave, lower right.

1. Gesso ground.
2. Green of first landscape: artificial malachite. Over this is a thin layer of surface dirt.
3. Light green underpaint of revised composition, mainly natural malachite with lead-tin yellow and white.
4. Further layer of opaque green: verdigris, lead-tin yellow + white.
5. Brown underpaint of cave, as layer 4 in (*c*).
6. Semi-glaze of verdigris followed by a glaze of red lake.

(e) Blue-grey shadow of dais, lower edge.

1. Gesso ground.
2. Layer of underdrawing similar in appearance to the intermediate drawing visible in (*c*).
3. Warm grey underpaint, perhaps bone black with lead white.
4. Cooler blue-grey incorporating some indigo.

(f) Green of shell, l.h.s. (The precise location of the paint fragment is not known.)

Multilayered green comprising a sequence of opaque mixtures of verdigris, lead-tin yellow and lead white, alternating with transparent and semi-transparent glazes of verdigris and 'copper resinate'. A detached fragment of pigmented varnish is visible at the top of the section.

(g) Deep blue of sky, upper r.h. edge.

1. Gesso ground.
2. Layers of indigo and lead white with an intermediate layer of discoloured azurite. These must represent the sky of the first composition.
3. Ultramarine and lead white underpaint of sky of revised design.
4. Glaze of high quality ultramarine.

(h) Pale blue sky, lower r.h. edge.

(Gesso ground missing from sample.)

1. As layer 2 in (*g*).
2. Two layers of pale blue containing scattered particles of ultramarine in a matrix of lead white.

(i) Yellow of dolphin above throne, l.h.s.

1. Gesso ground.
2. As layer 2 in (*g*).
3. Yellow underpaint for dolphin, as layer 3 in (*c*), with highlight of lead-tin yellow.

(j) Red of design on figure's sleeve, r.h.s.

(Gesso ground missing from sample.)

1. Pale blue of first painting of sleeve: ultramarine + lead white.
2. Thin layer of lead white.
3. Background to the revised design of the sleeve: lead-tin yellow with some vermilion and a transparent yellow.
4. Raised red velvet pattern: vermilion over a blocking-in with red lake pigment. Traces of a final lake glaze are also present.

(k) Pale yellow of sleeve, near wrist, l.h.s.

(Gesso ground missing from sample.)

1. Lead white, probably underpaint for the hand in its first position.
2. Thick layer of intermediate drawing.
3. Layer of pale pink as in layer 3 in (*b*), glazed with red lake. This represents the pink paint of the throne which at one stage extended further to the right.
4. As layer 3 in (*j*), with highlight of lead-tin yellow.

(l) Deep pink of drapery, l.h.s.

(Gesso ground missing from sample.)

1. Red lead (*minium*) underpaint for the first version of the drapery. Over this is intermediate drawing followed by a thin layer of lead white.
2. Series of semi-opaque and transparent layers of red lake (lac lake) with a little lead white.

(m) Green lining of cloak over knee.

1. Gesso ground with a layer of underdrawing.
2. Red lead (*minium*) as layer 1 in (*l*).
3. Opaque green lining of cloak comprising two layers of verdigris and natural malachite with lead-tin yellow.

(n) Pink of cloak over left shin.

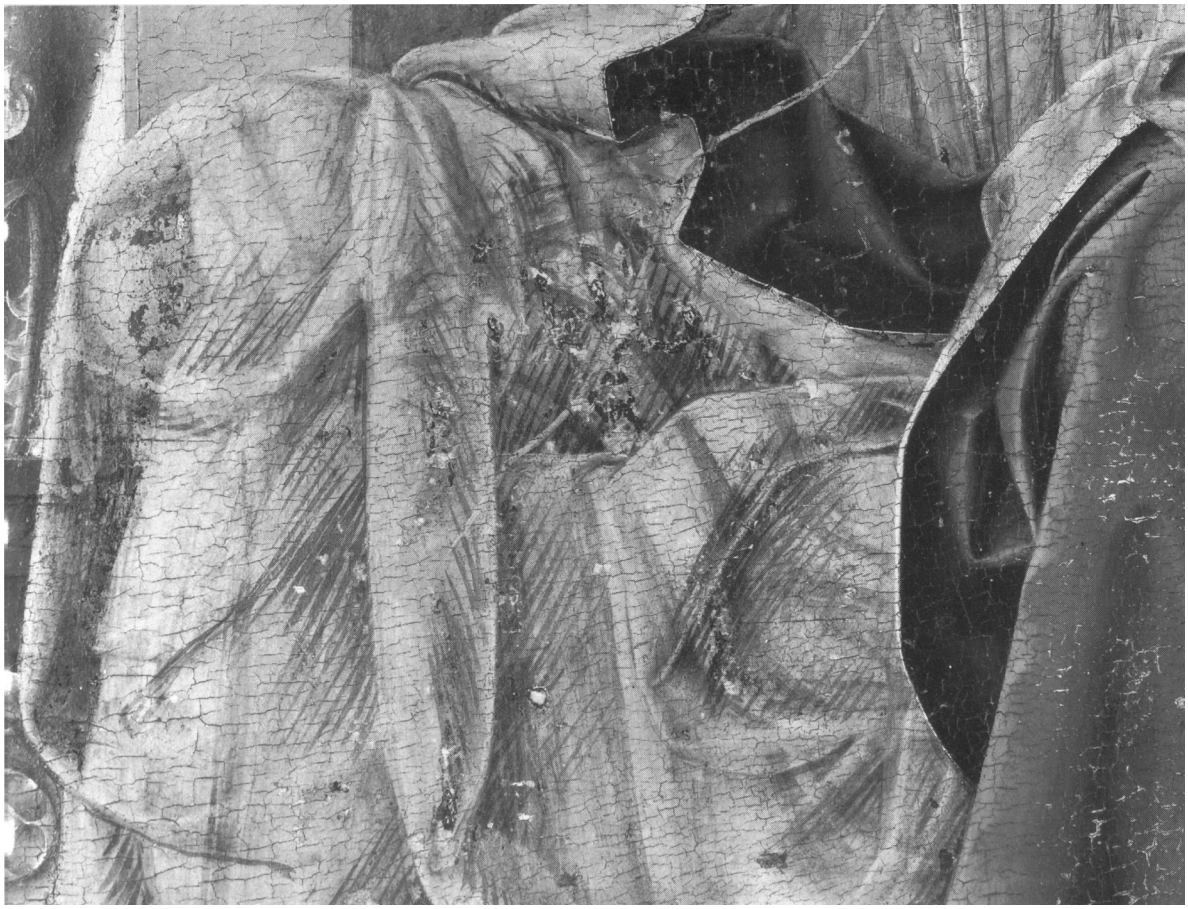
1. Gesso ground with a thin layer of underdrawing.
2. Pale blue underpaint for earlier position of skirt: lead white + ultramarine. This has been covered with a thin layer of lead white.
3. Pink of drapery: red lake and white over a red lake glaze. Traces of a final lake glaze are also present.

(o) Dark blue of skirt over left foot.

1. Gesso ground with underdrawing.
2. Red lead as layer 1 in (*l*). Over this is a line of intermediate drawing.
3. Indigo + white representing the underpaint for the revised position of the skirt.
4. Glaze of ultramarine reinforced with a red lake glaze.

(p) Pink of cloak over right knee.

1. Gesso ground (detached from sample).
2. Opaque green of unexplained feature in first version of composition (see text). Artificial malachite with some natural malachite, black and lead white. Over this is a thin layer of surface dirt.
3. As layer 3 in (*n*).



layer of a colder, blue-grey which contains some indigo with the black and white pigments. Although no samples were taken from the tantalizing fragment of a scroll or *cartellino*, it produces a relatively faint image in the X-radiograph and seems to have been painted immediately on top of the ground. The leaves and tendrils of the cucumber-like plant, on the other hand, have been superimposed over the white marble, having first been drawn in with lines of brown paint which are visible in some areas where the green paint has flaked away.

Similar drawing with brown or black paint could be seen over areas of a dull green-blue colour exposed by the flaking of the upper layers from the top of the throne (Plate 5, p.18) and especially from the shell-shaped canopy (Figs.20 and 21). Here lines of white paint have also been used to define the ribs and the outer edge of the shell. Some of these white lines appear in the X-radiograph and demonstrate that the shell has been slightly enlarged along the bottom edge. Adjustments have also been made where the edges of the shell curve inwards just above the fins of the dolphins. These changes must have been made during the later stages of painting as they can be detected in the infra-red photographs as well. The lines of black drawing still covered by green paint do not show in infra-red photographs but can be detected with the better penetration of the infra-red vidicon (Fig.16). The enlargement of the fluted edge is visible, and the outline of the right-hand dolphin is shown to continue beneath that of the shell. Cross-sections made from some of the fragments of paint removed during blister treatment (therefore lacking the ground and lower layers) still contain as many as six layers arranged as a sequence of opaque greens consisting of verdigris, lead-tin yellow and lead white, alternating with transparent and semi-transparent glazes of verdigris and 'copper resinate' [29]. The sample illustrated (Plate 6f, p.22) includes a very pale opaque

Figure 17
(Left, top)
Infra-red photograph detail, after cleaning, before restoration.

Figure 18
(Left, bottom)
Infra-red reflectogram detail.

Figure 19 *(Right)*
Detail of X-radiograph.

green as the penultimate layer. This may represent a highlight from one of the ribs of the shell or even one of the leaves from the spray of cherries, but for the reasons given earlier in this article, the exact location of the sample is not known. The discovery of so many layers in the green paint of the shell might suggest that the area had been extensively re-worked during painting, but apart from the small *pentimenti* described above, there is no indication of this in the X-radiograph. However, multi-layered greens have been found on paintings of the late fifteenth- and early sixteenth-century Venetian School so their use may have been a fairly common practice, perhaps with some traditional theoretical basis [30]. Certainly the technique produces green paint of great depth and richness and for some reason they do not seem to be as vulnerable to discoloration as those with a simpler layer structure. The green of the shell in *An Allegorical Figure* is noticeably less brown and discoloured than that on the throne, although to some extent this is due to the greater thickness of the final glazes.

The dull green-blue colour exposed by the flaking of the green paint can be seen in all the losses from the shell. It may now be somewhat altered in colour because of staining by the superimposed green layers and by remnants of old varnish and retouching, but it must have been intended to represent a sky, or the underpaint for a sky blocked in before the changes to the design were made. This supposition is confirmed by its occurrence in all the cross-sections made from samples taken from the present sky (for example, Plates 6g and 6h, p.22). The technique used for this sky is quite simple and the method is also evident on the surface of the picture. An underlayer of lead white and natural ultramarine has been painted around the main forms of the throne, occasionally passing under the outlines of the dolphins, particularly the one on the left-hand side of the throne where adjustments to the tail and other small changes are revealed by the X-radiograph. The gradation of the sky had already been established in this first layer: in a sample taken from near the horizon (Plate 6h, p.22) only a few ultramarine particles are visible in the matrix of lead white, but in samples from towards the top of the painting a high proportion of blue pigment can be seen (Plate 6g, p.22). The upper part of the sky has then been glazed with a second layer which also grades from almost pure ultramarine of the very highest quality [31] with only a little white at the top, to semi-glazes containing increasing amounts of lead white further down the picture. In the lightest blue at the horizon the second layer is even paler than the first, thus increasing the contrast with the deep blue at the top.

The green-blue paint beneath the ultramarine layers consists of between two and four layers of indigo mixed with lead white. Three of the samples (including the one illustrated) also contain a thin layer of azurite in between the first and second layers of indigo. In each case the azurite layer appears to be very rich in medium and extremely discoloured. Considering that it has been protected by the paint above, the extent of the discoloration is remarkable, so it can only be assumed that some technical problem occurred during the application of this layer, making it necessary to abandon it and cover it with more indigo and white. That the upper indigo

Figure 20
(Left) Detail after cleaning, before restoration.

layers belong to the earlier stage of the painting (as opposed to being a fresh underpaint for the ultramarine of the revised composition) is confirmed by their presence in samples from the left-hand end of the seat of the throne, and from the upper left dolphin, both of which are painted over the hypothetical first sky. The sample from the dolphin (Plate 6i, p.22) contains two layers of indigo divided by the discoloured azurite layer. The dolphin has then been painted over the indigo using the dark golden yellow mixture found elsewhere on the painting and the brilliant yellow highlights added with touches of pure lead-tin yellow. A thin layer of this was found on part of the sample.

Before restoration, dark patches of the dull indigo blue could be seen where the paint of the upper pair of dolphins is thin and abraded. The colour visible in the flake losses from areas as far apart as the shell canopy and the green marble seat of the throne is equally dark, so clearly the blue was not graduated like that of the later sky. Although one cross-section from about half way down the sky on the right includes a layer of lead white between the layers of indigo and those of ultramarine, which could be interpreted as a cloud and therefore taken as evidence that the indigo sky was virtually complete, it is difficult to believe that such a dull and dark blue could have been intended as the final colour [32]. It is more likely that the indigo layers were always meant to act only as an underpaint for the costly ultramarine which, in the end, was not applied until after the revision of the construction of the throne [33].

Paint layer structure and alterations to the figure

The X-ray image of the head and neck of the figure exhibits strongly contrasting modelling with such opaque highlights that the face appears almost as bony and knobbly as those of some of Tura's male figures. The reason for the difference between the face in the X-radiograph and that of the finished picture lies in the technique used for painting the flesh rather than in alterations to the design. The technique is clearly visible in damaged areas of the face and neck (Fig.11). Over the gesso and drawing is a monochrome undermodelling which varies from a cool grey on the shadowed side of her face and neck to a dense ivory white in the highlights. It must be this underpaint which is responsible for the strong image in the X-radiograph as the upper flesh-coloured layers which develop and refine the modelling of her features have been applied with the thinnest and lightest of touches, employing colours ranging from a very pale pink through to the warm transparent brown used to define the nose, ears and jaw line. The layer structure of the only sample of flesh paint from her face and neck (taken from a damage at the base of her throat) confirms these observations. Over the gesso is a thin layer of underdrawing which looks quite different from the thick, brown-black drawing usually seen as an intermediate layer elsewhere on the painting. Under the microscope the appearance of the drawing beneath the flesh suggests the use of an aqueous drawing material, possibly an iron gall ink [34]. The lower paint layer consists principally of lead white but with the addition of a small amount of an orange and perhaps also a yellow pigment. This accounts for the warm ivory colour seen in the undermodelling. As the sample comes from a highlight, the true flesh colour again contains mostly lead white but this time lightly tinted with red lake and vermilion.

Although there are no apparent alterations to the figure's face several changes have occurred in her hair and headdress. Flaking of the upper paint layers shows that originally her hair was held back with a band of rolled or padded fabric painted with a dull blue-grey colour (possibly intended only as an underpaint for a brighter blue pigment).This has been converted into a section of hair twisted with white ribbon and coiled around her head. The paint of the hair was not sampled but it appears to consist of an opaque underpaint of dark yellow in the highlights and a pinkish brown in the shadows, all glazed with a rich, red-brown, probably based on the same sort of mixture as that used to model the dolphins. A different outline to the hair, especially at the right of her head, is revealed by the X-radiograph. The area contained by this earlier outline is so transparent to X-rays that it would appear to have been reserved, unpainted, right from the application of the very first layers associated with the original composition. If this is the case, it confirms that the position of the head has remained unaltered throughout the changes to the design.

The dark blue bodice and the upper part of the skirt have also escaped alteration. A sample taken from a fold of the skirt to the right of the laced opening fortunately includes a substantial layer of underdrawing. It lies immediately over the ground, thus establishing the position in the layer structure of the drawing visible in infra-red on the bodice and, by implication, that which has been used to sketch in the knees and drapery in the initial lower position. The paint has been applied in two layers, the first consisting of a pale blue layer of natural ultramarine with lead white, and the second of a glaze of natural ultramarine mixed with a large quantity of medium. Even in the cross-section this can be seen to have darkened and discoloured.

A light blue colour apparently the same as that used to underpaint the dark blue could be seen at the edges of flake losses from the brocade of the figure's left sleeve. The only *pentimento* visible in the X-radiograph on this sleeve is a small adjustment to the point at which the pink cloak is attached to her shoulder, so the light blue must indicate a change of colour rather than a complete redrawing of the arm. A sample taken from this sleeve (Plate 6j, p.22) confirms the colour change and shows how the raised velvet pattern of the sumptuous brocade was achieved. The gesso and any possible underdrawing have separated from the sample so the first layer in the cross-section is the light blue which is indeed identical in composition to that beneath the bodice and skirt. Between the blue and the next paint layer which consists of a thin application of lead white, is a layer of what appears to be dirt. This produces a marked sense of discontinuity between the two paint layers and implies that the pale blue belongs to the first stage of painting before the alterations to design. Due to the large quantity of discoloured medium in the upper layer of the sample from the skirt described above, it was impossible to detect a similar discontinuity between the paint layers,

Figure 21
(Left) Infra-red photograph detail, after cleaning, before restoration.

Figure 22
Detail after cleaning, before restoration.

but the two layers of blue in that sample may also represent the different stages in the production of the painting. The lead white layer above the blue in the cross-section of the sleeve appears to be one of the relatively few instances of Tura blocking-out the underlying colour and form before embarking on the new design. The golden part of the brocade has then been painted with layers of a warm, orange-yellow, made up of lead-tin yellow, vermilion and a transparent yellow pigment. Over this the red pattern has been laid in with a glaze of red lake which has in turn been covered with a more substantial opaque layer of vermilion and finally glazed with further red lake.

The ultramarine and white underpaint was also visible in some of the losses from the other sleeve, but here interpretation of the samples is complicated by an alteration to the position of her raised arm. It can be seen in the X-radiograph that it was originally placed rather lower with the elbow tucked well into her side. A sample from the upper part of her forearm (and therefore not expected to include the paint of the first sleeve) was found to contain as its lowest paint layer, the familiar yellow mixture of the columns of the first throne. Next is a thick layer of intermediate drawing followed by a layer of lead white like that in the sample from the left sleeve. In addition to covering the blue this may have been intended to mask the heavy line of drawing. The golden brocade of the sleeve has been painted with a single layer of lead-tin yellow with a little vermilion but it is separated from the white lead by a very thin yellow-brown glaze which probably represents a sketching in of the sleeve with a transparent yellow paint. The other sample from the right sleeve (Plate 6k, p.22) was taken from a damage coinciding with the location in the X-radiograph of what appears to be an earlier hand. This hand can only have been laid in before the position of the arm was moved, as the cross-section shows just one layer of lead white beneath the several paint layers which are associated with the revised design. Above the lead white layer, which is presumably the equivalent of the ivory-coloured undermodelling in the face and neck, is a characteristically thick line of intermediate drawing, and then a pale, but warm pink colour glazed with a layer of red lake. These two pink layers occur because of a slight overlap of the paint from the pink marble of the throne which, as revealed by the X-radiograph, at one time continued further to the right underneath the present outline of the robe. The sleeve itself has been painted with the same mixture of lead-tin yellow and vermilion as on the left sleeve, and this time the sample includes a layer of the pure lead-tin yellow used to highlight the gold threads of the brocade.

In her right hand the figure holds a branch of cherries. The X-radiograph suggests that the area of the lower part of the branch has been reserved while applying the very X-ray opaque underpaint of the pink throne, but elsewhere the cherries have been painted over the completed paint layers. A sample from one of the brown leaves at the top edge of the picture was found to contain a mixed brown like that on the dolphins, proving that the leaves were always intended to differ in colour from those in front of the shell-shaped canopy. An interesting feature of the sprays of fruit and leaves is a series of very small white dots around and sometimes beneath the paint of their outlines (Fig.22). Similar dots can also be seen in areas of the figure's hair, particularly where it falls over her left shoulder (Fig.11). An obvious explanation for their presence is that the technique of pouncing has been used to transfer full-scale drawings of these details to the painting, but it is equally possible that the dots have simply been used as a discreet method for outlining the shapes and that they have been applied freehand without the use of a pricked cartoon.

The cross-sections from the lower part of the figure are as complex in their layer structure as those from the rest of the picture. The reasons for this can be found in the X-radiograph which demonstrates that the figure's legs and drapery were not only drawn in the lower

position visible in the infra-red photographs and reflectograms, but that a certain amount of paint had also been applied. Several folds of drapery not associated with the present design can be detected, including those draped over her knees as in the first drawing. In many of the damages on the pink robe or cloak traces of a bright orange paint could be seen. The same colour appears as the lowest layer in a sample from a shadowed fold over the inside of the figure's right thigh (Plate 6l, p.22). The pigment has been identified as red lead (lead tetroxide) (Fig.23) which is seldom found on fifteenth-century Italian paintings and then usually only as an underpaint for vermilion [35]. Over the red lead is a line of drawing, part of the hatched shading used to remodel the drapery folds. In this particular cross-section the drawing can be seen to consist of a few black particles in a brown matrix of what appears to be mostly medium. Just as in the samples from the sleeves, the intermediate drawing and the first underpainting have been covered with a thin and rather discontinuous layer of lead white before the application of the paint layers constituting the final pink drapery.

It is possible that this lead white represents a drawing in of the highlights of the redesigned drapery similar to that on the ribs of the shell. This would account for the lines of parallel hatching visible in the X-radiograph (Fig.4), especially over the figure's right knee. However, the obliteration of the red lead even if only partial, is evidence that it was not supposed to contribute optically to the cool pink of the present colour, and that the drapery was probably originally to be completed with layers of the brighter red vermilion, and then perhaps glazed with red lake. Instead vermilion has been used only over the colder blue-red to produce a velvet pile effect in the shadows of the folds. Some of this vermilion can be seen at one end of the cross-section illustrated. It lies over a deep red composed of glazes of red lake and lead white. As with the more complex green samples, the number of layers present might suggest yet more alterations during painting, but again examples of reds with multiple alternating layers of opaque and transparent colours have been found on other fifteenth- and early sixteenth-century Italian paintings [36]. The source of the dyestuff of the red lake pigment has been identified as lac and is therefore the same as that used for the pink marble of the throne [37]. The marked colour difference between the cold, blue-red of the drapery and the warm, brownish pink of the throne must be entirely due to the inclusion of a transparent yellow pigment in the opaque underlayers for the latter.

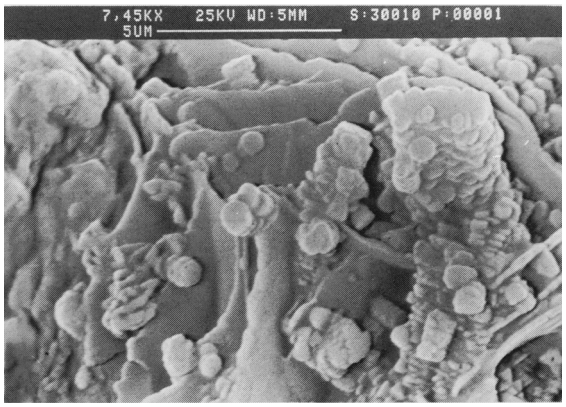


Figure 23 SEM micrograph of an aggregate particle of red lead (*minium*) from the lowest paint layer of the cloak. Gold-coated, 7450×.

The layer of red lead found under the pink drapery extends beneath the green lining of the robe where it has been turned back over the figure's left knee and shin. It could be seen at the edges of the cracks and flake losses and also occurs in the cross-section from this area (Plate 6m, p.22). In the original design revealed by the infra-red reflectogram the lining would not have shown, so the drapery would have appeared as red. The cross-section includes a thick line of the first underdrawing but no intermediate drawing is present. The green paint of the lining lies directly over the red lead and has been applied in two layers using an opaque mixture of verdigris, malachite and lead-tin yellow. As the sample comes from a highlight the upper layer is considerably lighter in colour. Further down the figure's left shin and below the green lining, a pale blue colour was visible underneath parts of the pink drapery. A cross-section (Plate 6n, p.22) confirmed that this contains the same combination of natural ultramarine and lead white used as an undermodelling for the upper part of the blue dress and suggests that originally more of the blue skirt was to be exposed. As with other samples from the pink drapery, the first colour has been partially covered with a thin application of lead white, again perhaps a highlight from the intermediate drawing. Some surface dirt may be trapped between these two layers. The cross-section was taken from a mid-tone so the pink consists of an opaque layer of red lake, with a fairly high proportion of lead white followed by a thin glaze of red lake but, in common with the samples of red paint from the pattern on the sleeve and from the shadow of the fold, the opaque pink layer is preceded by a much darker glaze or semi-glaze of red lake. This may have been intended to have an optical function or it could just represent a preliminary blocking-in of the colour area.

Alterations to the position as well as to the size of the opening which reveals the blue skirt account for the complex layer structure of samples from the figure's left foot and from the area of blue skirt now visible. The cross-section from the skirt (Plate 6o, p.22) includes a layer of the red lead underpaint between lines of both preliminary and intermediate drawing. The blue colour of the revised design has been laid in with lead white and indigo rather than the natural ultramarine used in the earlier phase of underpainting. This has then been glazed in the same way as the rest of the dress with natural ultramarine mixed with a high proportion of medium. Finally, the deep shadow of the fold has been emphasized by the addition of a thin glaze of red lake [38]. The use of this red lake glaze (which now appears almost black on the surface of the painting) has been restricted to the lower part of the skirt.

The ultramarine and white underpaint from the first version of the skirt features again in a sample from the shadowed side of the arch of the figure's left foot. Here it has been covered with a thick line of intermediate drawing and then a single layer of brown paint comprising the same mixture of black, red lake, vermilion, iron oxide and lead-tin yellow found elsewhere

on the picture. Meanwhile, the red lead layer also recurs in a sample from the foot, this time from a damage on the nail of the big toe. Above it lies a pale grey which could represent a monochrome undermodelling, but this has been covered with a heavy line of drawing and then two further layers. The first consists of almost pure lead white and the second includes a few particles of vermilion and red lake with the lead white, and is therefore exactly the same as that used on the palest areas of the face and neck. Despite the use of identical pigment mixtures, the flesh paint of the feet and hands appears rather cold and grey when compared with the fresh pink colour of the face. In the case of the feet and of the figure's right hand this must be due to the influence of the various underlying colours, whereas the undermodelling and flesh paint of the face and neck lie directly over the light-coloured ground.

With all the paint samples described so far it has been possible to find plausible explanations for the many and different coloured layers of paint. A few cross-sections remain where the layer structure is difficult to account for. An example is a section from a loss towards the top of the figure's right knee (Plate 6p, p.22). The upper paint layers are consistent with the rest of the drapery, following the sequence of a lead white masking layer, a red lake glaze, an opaque pink and finally a thin red lake glaze, but beneath these and separated from them by surface dirt is a very thick layer, or possibly layers, of opaque green based on a mixture of both the natural and the artificial forms of malachite with verdigris and some black and lead white. The sample point coincides with a shadowy wedge visible in the infra-red photographs (Fig.15) along the left edge of the figure's leg. The dark image is the result of absorption of infra-red by the dull green colour, some of which is visible where exposed by flaking of the upper layers of pink paint. The green colour also appears in flake losses from the coiled tail of the bottom left dolphin, the green marble ledge of the present throne (where a sample of just the underpaint confirmed that it was of similar composition to that beneath the pink drapery) and continues beneath the lower jaw of the middle dolphin, featuring as the first layer of a sample from the large circular damage on its fins. As the green mixture contains a little lead white and lead-tin yellow a faint image can sometimes be detected in the X-radiograph. What the image represents is still a mystery [39].

The paint medium

The results obtained from analysis by gas-chromatography of eight paint samples [40] concur to a remarkable and satisfactory extent with the conclusions drawn from the interpretation of the cross-sections and the infra-red and X-ray images. Because of the cleavage between the various paint layers it was possible to investigate samples comprising only the lower layers assumed to be the underpaint for the abandoned first composition. The four samples, one from the red lead beneath the robe and three from the green paint of the unexplained feature to the left of the figure, were found to be egg tempera. The upper layers appear to have been painted in oil. Walnut oil was identified as the medium of the light-coloured paint from the white marble dais, but samples from the darkest blue of the sky, the green shell and the red and green glazes of the robe and its lining all contain linseed oil with addition of a certain amount of resin to increase the richness and transparency of the paint. Analysis of a further sample from the green shell detected the components of pine resin [41].

Summary

Sufficient information has been supplied by the technical examination of Tura's *An Allegorical Figure* to reconstruct and summarize the different stages leading to the creation of the final image (Fig.24).

The first stage would have been the drawing of the initial design on to the prepared panel (then rather larger than at present). The main arcs and vertical lines of the throne, originally conceived as a semi-circular arrangement of tall, narrow columns, were incised into the gesso and the figure drawn in, probably using an aqueous drawing material applied with a brush. The position of the upper part of her body was, with the exception of her right arm, the same as that now visible; but her legs were drawn so that the knees were placed both lower and closer together, giving the angle of her thighs a downward tilt. The drapery was disposed quite differently with a prominent fold of bunched fabric suspended across her knees. The drawing technique is quite free and sketchy without much hatching to define the modelling and distribution of light and shade.

Most of the colour areas established in the underdrawing then received an application of one or more layers of paint. The figure's robe was painted with a single layer of red lead, presumably intended as an underpaint for vermilion. The bodice and sleeves of the dress were painted pale blue with a mixture of natural ultramarine and white, again probably as the base for a further application of ultramarine. The same ultramarine and white appears at the opening which shows the skirt. This was to the left of that now visible and extended further up. The figure's right foot may not have been shown and there was no turned back lining over her right knee. The areas of the landscapes were blocked in with a green colour based on artificial malachite. The horizons may have been a little higher and flatter than at present and the green paint extends slightly beneath each end of the dais. No paint seems to have been applied to the area of the dais [42]. The sky was laid in with between two and four layers of indigo and white, sometimes with an additional intermediate layer of azurite, but the uppermost layer was left as a dull, dark blue without any gradation of colour towards the horizon. The columns of the throne were painted a golden yellow, with their cylindrical forms modelled in the opaque underlayer and possibly with a transparent yellow glaze as well. The extent to which the flesh had been painted is not clear. No samples were taken from the figure's left hand but the right hand seems to have been underpainted in its first position with a layer of lead white. It is just possible that a similar underpainting occurred on the face but was later mostly scraped off; in flake losses at the top of her

Figure 24 Reconstruction of the first version of the design based on the evidence provided by technical photography and examination.

forehead there does appear to be an extra layer of ivory-coloured underpaint and the paint around her hairline is particularly opaque in the X-radiograph [43]. The earlier outline of the hair and the first version of the headdress may also belong to the original design. The mysterious green shape to the left of the figure must be associated with this stage and it is evidently an integral part of the composition since in all the cross-sections in which it features it lies directly over the ground. While the results of analysis of samples from only two areas of colour cannot be taken as representative of the whole painting, it would appear that this first phase was executed in egg tempera. The impression gained of this hidden design at the point when it was abandoned (Fig.24) is that, with its empty sky and different position of the lower body, it had much in common with some of the other panels with which the finished picture is usually linked, and in particular the pair of enthroned figures in the Strozzi Collection, Florence.

Before the painting was taken up again, an interval seems to have passed of sufficient length for a layer of smoke and dirt to have settled on its surface. This may have been no longer than a year or two, since with open fires and lighting by candles and oil-burning lamps, surface dirt would have accumulated fairly rapidly. However, the apparent time lapse between the first and second versions of the composition does raise the question of Tura's responsibility for the original design. Obviously when working from confused and much obscured images in X-radiographs and infra-red photographs and reflectograms, it is difficult to be certain, but it can be said in favour of Tura's authorship that the first underdrawing, although rather different in style from that usually seen on his paintings, is entirely characteristic in its approach to the construction of the figure. An almost identical drawing in of the breasts and nipples of fully clothed figures can be seen in infra-red photographs of his later *Virgin and Child Enthroned* (*Central Panel from an Altarpiece*) (No.772; Figs.25 and 26) [44], and a concern for the underlying anatomy of both humans and animals is evident in other underdrawings. In addition, on two occasions, Tura is actually documented as having altered and adapted paintings for his patrons [45] and certain of the rather unusual pigments identified in the palette for the original design are listed among expenses incurred for some of his other works [46].

There are indications in some of the cross-sections that when work on the painting was recommenced, the paint surface of the first composition was slightly abraded in some way so as to improve the adhesion of the subsequent paint layers. This would account for the absence of an obvious dirt layer in many of the samples. The lines and curves of the new throne were then scored quite deeply into the underlying paint and gesso [47], and the architectural details, the shell and the dolphins drawn in over the different coloured paint layers. The complete re-drawing of the lower part of the figure which greatly increases the sense of being seen from below, was also made directly on top of the first design. The modelling of the folds and the placing of the shadows were established with bold strokes of parallel hatching. The drawing material used is almost certainly some form of paint. An ink would not take well to the paint beneath, and areas of drawing exposed by flaking were totally resistant to aqueous reagents used during cleaning.

The upper painting has been executed using an essentially Early Netherlandish painting technique in which the colour areas are systematically undermodelled with opaque pigment mixtures, and then completed with applications of transparent and semi-transparent glazes. Tura has used the oil medium with great skill and sophistication. The discovery of walnut oil in the sample from the white marble dais suggests that he may have deliberately chosen the less yellowing oil for areas of light-coloured paint, while the addition of the resin to the linseed oil of the darker glazes must contribute to their richness and transparency. There are no signs of the drying cracks and similar technical defects which frequently affect other apparently early essays by Italian painters working in oil-based media.

If the panel is accepted as being from the *studiolo* at Belfiore where Tura is recorded as having worked from 1459 to 1463, it becomes the earliest securely-dated Italian picture in the National Gallery to have been identified by reliable analytical methods as having been painted principally in oil [48]. The discovery that it has been altered to an extent that is most unusual for an easel painting of the mid-fifteenth century [49] fuels the

debate about its subject matter. Even allowing for Tura's tendency to superimpose details over fully completed forms, it is evident that none of the elements of the final composition which have been so variously interpreted in the past were incorporated in the original design. Indeed it is possible that the first version represented a quite different subject and that the reason for the re-working was a change in the iconographical programme. However, it would probably be unwise to speculate on this until similar technical information can be obtained from the other paintings thought to be from the same decorative scheme.

For the present *An Allegorical Figure* must be considered in isolation, unique among the paintings by Tura in the National Gallery in its complexity of technique and depth and saturation of colour [50]. Surely it must be the most striking surviving example of Tura's response to the works by Rogier van der Weyden known to have been in Ferrara, not only in such obvious details as the brocade sleeves, the shape of the figure's face and the method of depicting clouds, but also in the novel technique with which it has been painted.

Notes and references

1. Microscopical identification on a thin section of the end-grain.
2. These repairs must look very like those discovered during the removal of the wood from Cima's 'The Incredulity of S. Thomas' (No.816). They are illustrated in Wyld, M. and Dunkerton, J., 'The Transfer of Cima's "The Incredulity of S. Thomas"', *National Gallery Technical Bulletin*, **9** (1985) p.50, Fig.9 and p.52, Fig.11.
3. The characteristic form of flax fibres was identified under the microscope.
Patches of canvas have also been discovered beneath areas where the gesso has flaked off on Tura's 'The Virgin and Child Enthroned (Central Panel from an Altarpiece)' (No.772), but they appear to have been applied only over the joins and faults and not over the whole panel.
The glueing of a layer of fine canvas over the panel before the application of the gesso layers was a fairly common practice in the fourteenth century, but by the mid-fifteenth century it usually seems to have been dispensed with.
4. This characteristic was noted when the picture was bequeathed to the National Gallery in 1916. Its condition was then recorded as 'doubtful: surface much cracked and very dry'. (National Gallery 'Manuscript Catalogue'.)
5. The painting was sent to William Morrill and Son who frequently carried out structural work on National Gallery pictures.
6. The fact that it has been possible to reconstruct this period of the Tura's conservation history is entirely due to the researches of Dr Jaynie Anderson into the activities of the group of art historians, collectors and restorers centred on Milan in the mid-nineteenth century and including Giovanni Morelli, Otto Mündler, Sir Charles Eastlake, Sir Austen Henry Layard and Giuseppe

Figure 25 Tura, *The Virgin and Child Enthroned* (No.772), infra-red photograph detail.

Figure 26 Tura, *An Allegorical Figure*, infra-red photograph detail.

Molteni. I am very grateful to Dr Anderson for her generous assistance and particularly for allowing me to read the manuscript of her article 'The Restoration of Renaissance Painting in Mid-Nineteenth-Century Milan: Giuseppe Molteni's Letters to Giovanni Morelli' which will be published in *The Burlington Magazine* in the course of 1988.

7. Mündler Travel Diary II, June 1857–June 1858, f.57v. (National Gallery Archive.) Mündler's travel diaries are to be published with a preface by Dr Anderson in *The Walpole Society*, Vol.51.

8. Letter from Layard to Morelli, 6 November 1866. British Library, Add. MSS 38,966. See ANDERSON, J., 'Layard and Morelli' in the proceedings of the conference 'Austen Henry Layard tra l'Oriente e Venezia', Venice (1987), p.118.

9. For accounts of the re-cleaning of other National Gallery pictures known to have been restored by Molteni, see ANDERSON, J., *op. cit.;* GOULD, C., 'Eastlake and Molteni', *The Burlington Magazine*, **CXVI** (1974), pp.530–34; and BOMFORD, D., BROUGH, J. and ROY, A., 'Three Panels from Perugino's Certosa di Pavia Altarpiece', *National Gallery Technical Bulletin*, **4** (1980), pp.3–18.

10. Molteni died in January 1867 only a few months after the arrival of Layard's Costabili acquisitions. On 4 February 1867, Layard wrote to Morelli from London: 'A few days before his death Molteni sent me my Savoldo and some paintings from the Costabili Gallery. But the larger part of my paintings are still in his studio [....] I shall send them instead to M. Pinti, our best restorer here.' British Library, Add. MSS 38,966. Although it is not recorded whether the Tura was among the paintings Molteni treated before his death, it is likely to have been given priority as one of the more important works from the collection.

11. Molteni thanked Morelli for sending him some Cassel earth in a letter dated 25 January 1860, to be published in ANDERSON, J., *op. cit.* According to the manual on the restoration of paintings by Secco-Suardo it was the common practice of leading nineteenth-century Milanese restorers to patinate newly cleaned pictures with a mixture of Cassel earth and beer. See SECCO-SUARDO, G., *Il Restauratore dei Dipinti*, Part II (Milan 1894), pp.318–19.

12. See GETTENS, R.J. and STOUT, G.L., *Painting Materials: A Short Encyclopaedia*, Dover Edition (New York 1966), p.168.

13. LONGHI, R., *Officina Ferrarese* (Rome 1934), p.26.

14. RUHMER, E., *Cosimo Tura* (London 1958), p.22.

15. They have been preserved for analysis by the Scientific Department and have been used, for example, to make the cross-section illustrated in Plate 6f, p.22.

16. The condition and appearance of the face seems to have been unsatisfactory even before the restoration of 1866–67. When Sir Charles Eastlake saw the picture in the Costabili Collection in 1858 he expressed his doubts about the head, describing it as 'rather rudely painted and warm and low in tint with salient lights — not very successful [...] the head out of drawing and careless renders the whole objectionable — possibly repaired.' He recorded that the painting was 'otherwise not in a bad state', but it was evidently extremely discoloured as he was uncertain as to whether the figure's laced bodice was dark blue or dark green. Eastlake Notebook (1858), Vol.II, f.1v. (National Gallery Archive.)

17. Alinari no. 13610 and Anderson no.12042. The latter, which shows some unretouched flake losses from the trailing hem of the robe on the right, is reproduced in ORTOLANI, S., *Cosme Tura, Francesco del Cossa, Ercole de' Roberti* (Milan 1941), plate 4.

18. Once the nineteenth-century additions had been removed the sight size of the frame was 113.5 cm by 74 cm which is quite close to the dimensions of Tura's cut-down panel. While this may be a coincidence and the motivation for adapting this particular frame for the panel in the nineteenth-century, it is just possible that the frame and the painting have been associated for longer, and that the panel could have been cut to fit the frame or even that the frame was made to fit the already mutilated panel.

19. See DAVIES, M., *Rogier van der Weyden*, Phaidon (London 1972), p.118. It is sometimes suggested that van der Weyden may even have visited Ferrara on a putative pilgrimage to Rome in 1450.

20. See for example, SMITH, A., REEVE, A. and ROY, A., 'Francesco del Cossa's "S. Vincent Ferrer"', *National Gallery Technical Bulletin*, **5** (1981), pp.54–5; DUNKERTON, J. and ROY, A., 'The Technique and Restoration of Cima's "The Incredulity of S. Thomas"', *National Gallery Technical Bulletin*, **10** (1986), p.5; and GETTENS, R.J. and MROSE, M.E., 'Calcium Sulphate Minerals in the Grounds of Italian Paintings', *Studies in Conservation*, **1**, 4 (1954), pp.182–83.

21. For other examples of grounds on Italian paintings which appear to have been sealed in this way, see DUNKERTON, J. and ROY, A., *op. cit.*, p.5 and Note 10, pp.24–5.

22. Extensive underdrawing is visible in infra-red photographs of the three other paintings by Tura in the National Gallery. Infra-red reflectogram details of the organ shutters in the Duomo, Ferrara also show characteristic underdrawing, see BENTINI, J. (ed.), *San Giorgio e la Principessa di Cosme Tura: Dipinti restaurati per l' officina ferrarese*, Nuova Alfa Editoriale (Bologna 1985), p.19. In many paintings by Tura underdrawing can easily be detected with the naked eye.

23. The painting was scanned using a Hamamatsu C2400 video camera. This revealed underdrawing which had not been visible with earlier infra-red vidicon equipment.

24. Lead-tin yellow 'type I' was confirmed in a separated sample by X-ray diffraction analysis. Microscopically it seems to be mixed with yellow ochre and a transparent yellow pigment. Spectrographic analysis by LMA showed lead, tin, iron, silicon and aluminium. Full identification of the transparent yellow pigment which occurs here and elsewhere on the picture is difficult as it is nearly always present in mixture with other pigments. See also DUNKERTON, J. and ROY, A., *op. cit.,* p.17 and Notes 38–39, p.27.

25. Identification by Raymond White using high-performance liquid chromatography (HPLC).

26. Microchemical test for aluminium using morin. See FEIGL, F., *Spot Tests in Inorganic Analysis*, 6th ed., Elsevier (London 1972), pp.95–6.

27. Malachite of this particle form has also been found on another Ferrarese panel of the fifteenth century. See SMITH, A., REEVE, A. and ROY, A., *op. cit.,* p.55, Notes 6–13 and Plate 13b, p.44.

28. Superimposed red and green glazes have also been found on areas of drapery in Cima's 'The Incredulity of S. Thomas', see DUNKERTON, J. and ROY, A., *op. cit.*, pp.15–6 and Plate 2, p.12.

29. The identification of a conifer resin, probably pine, in the medium of the green glazes (see p.93 of this article) suggests that these glazes are properly described as 'copper resinate'.

30. See DUNKERTON, J. and ROY, A., *op. cit.,* p.15 and Note 34, pp.26–7.

31. A document of 1460 relating to the *studiolo* at Belfiore records a payment for 'onze tre e meza de azuro oltramarino fino del qualle ne fue fato merchato per Cosme depintore per lo studio de lo prefato nostro Signor' [three and a half ounces of fine ultramarine blue which was bought for Cosimo the painter of the study of our aforesaid lord]. See VENTURI A., 'Cosma Tura genannt Cosmè', *Jahrbuch der Königlich Preussischen Kunstsammlungen,* **9** (1888), p.8. Ultramarine of particularly high quality also occurs on other paintings commissioned by members of the d'Este family, and now in the National Gallery, notably 'Bacchus and Ariadne' (No.35) by Titian and 'A Man Embracing a Woman' (No.1234) by Dosso Dossi. See LUCAS, A. and PLESTERS, J. 'Titian's ''Bacchus and Ariadne''', *National Gallery Technical Bulletin*, **2** (1978), p.40; and BRAHAM, A. and DUNKERTON, J., 'Fragments of a Ceiling Decoration by Dosso Dossi', *National Gallery Technical Bulletin*, **5** (1981), p.30.

Judging from her correspondence, Isabella d'Este seems to have shared the family concern to obtain the best pigments available. For example, in 1496 she sent her agent in Venice a list of pigments to be bought, together with 'li parangoni in una scatoletta' [the paragons in a little box]. The agent managed to find all the pigments requested except for the 'azuro' (presumably ultramarine) which did not match up to the required standard. Eventually he was allowed to buy blue of a different quality but it still had to be 'il più bello che in Venetia se trova' [the most beautiful that can be found in Venice']. See VERHEYEN, E., *The Paintings in the Studiolo of Isabella d'Este at Mantua*, New York University Press (New York 1971), note 25, p.12.

32. On the other hand Tura's 'Portrait of a Young Man' in the Metropolitan Museum, New York, and 'The Virgin and Child in a Garden' in the National Gallery, Washington, which are usually accepted as early works, have backgrounds of a dark, unmodulated blue similar to another picture connected with Ferrara, 'Lionello d' Este' (No.770) by the mysterious Giovanni da Oriolo. This may have been the subject of a payment in 1447. See DAVIES, M., *The Earlier Italian Schools*, National Gallery Catalogues (London 1961), p.241. A sample from the background shows it to have been painted with azurite over a layer of indigo apparently unmixed with white. The medium has been identified by gas-chromatography as egg tempera. See MILLS, J.S. and WHITE, R., 'The Gas Chromatographic Examination of Paint Media. Some Examples of Medium Identification in Paintings by Fatty Acid Analysis' in *Conservation and Restoration of Pictorial Art*, N. Bromelle and P. Smith (eds.), Butterworths (London 1976) p.74.

33. Indigo also occurs as an underpaint for natural ultramarine in the sky of Francesco Cossa's 'S. Vincent Ferrer' (No.597). See SMITH, A., REEVE, A. and ROY, A., *op. cit.,* p.55.

It is listed among the pigments used on a design for a tapestry for which Tura was reimbursed in 1457 (see VENTURI, A., *op. cit.*, p.7) and also features in the valuation of materials used in the decoration of the chapel at Belriguardo in 1472. According to this document, which gives a fascinating insight into the relative costs of the different pigments, the gilded stucco reliefs and friezes had a blue ground built up with an elaborate layer structure not unlike that of the sky in 'An Allegorical Figure'. The first layer consisted of a blue made from lead white and indigo [de azurato de biacha e de endego], followed by a layer of coarse azurite [azuro todescho grosso] of a quality valued at one ducat per pound of pigment, then a layer of fine azurite [azuro todescho fino] at three ducats per pound, and finally an application of ultramarine costing thirty-six ducats a pound. See VENTURI, A., *op. cit.*, pp.18–19.

34. Examination of a sample of the drawing layer from beneath the flesh of the neck showed fine brownish black particles, unlike any of the forms of vegetable black pigment, embedded in a translucent brown matrix. A few larger particles which are clearly carbon are also present, but the bulk of the material is soluble in concentrated hydrochloric acid, suggesting an iron compound. Iron was also detectable by LMA at low concentrations as the only metallic element in a carefully separated sample.

35. For example in the red robe of S. John in 'Christ Crucified' (No.1166) by Antonello da Messina. Red lead has been used on its own for the oranges in Paolo Uccello's 'Niccolò Mauruzi da Tolentino at the Battle of San Romano' (No.583), and has been identified on several sixteenth-century Venetian paintings, but not necessarily as an underpaint for vermilion. See LAZZARINI, L., 'Il Colore nei Pittori Veneziani tra il 1480 e il 1580', *Bollettino d'Arte*, Supplemento 5 (1983), pp.138–41. Red lead is also listed in both the documents cited in Note 33 above. The valuation of the materials used at Belriguardo demonstrates that it cost only one-fifth of the price of the vermilion to be applied over it.

36. See DUNKERTON, J. and ROY, A., *op. cit.,* p.14 and Note 31, p.26.

37. Identification as a lac lake by HPLC. Despite the great difference in colour between the pink of the throne and that of the drapery, microspectrophotometric measurements in the visible region of glaze samples by transmitted light showed their spectra to be identical, confirming the use of the same dyestuff for the lake pigment in both areas. See also Note 10, p.84 of this *Bulletin*.

38. Although the layer structure has not been confirmed by cross-section, red lake glazes can be seen to have been applied to the shadows of the folds of the blue drapery worn by the right-hand angel in Piero della Francesca's 'The Nativity' (No.908).

In his section on fresco painting Cennino suggests

defining the folds of an ultramarine drapery with a little red lake mixed with black. See THOMPSON, D.V., *The Craftsman's Handbook. 'Il Libro dell'Arte' of Cennino d'Andrea Cennini*, Dover Edition (New York 1954), p.55.

39. Areas of green paint could also be seen in flake losses from the body and tail of the dolphin at the base of the throne on the right. Unfortunately there was no suitable sample point, but the colour is much richer and darker than that of the hidden feature on the left and more like that of the green marble seat of the throne. It is likely that the side of the throne was first painted green and then changed to the brownish pink now visible.

40. See 'Analyses of Paint Media', p.92ff.

41. Analysis by gas-chromatography–mass-spectrometry showed the presence of dehydroabietate and minor quantities of 7–oxodehydroabietate components of pine resin. The binding medium was linseed oil.

42. The simple layer structure of the paint samples and the observation that the underdrawing in the samples looks like that used as intermediate drawing elsewhere on the picture suggests that little had been done to this area before the design was revised.

43. That Tura did occasionally scrape off areas of unwanted paint is suggested by an examination in raking light of 'The Virgin and Child Enthroned' (No.772). Crescent-shaped depressions in both paint and ground with quite pronounced scrape marks can be seen at the curved bases of the panels bearing Hebrew inscriptions on either side of the throne. There are no signs of such vigorous scraping on 'An Allegorical Figure'.

44. In his 'Nativity' (No.908), Piero della Francesca has drawn in the chest of the shepherd with an upraised arm in a similar, if more sketchy manner. This drawing can just be detected with the naked eye, but is more evident in infra-red photographs.

45. In 1456 Tura modified a banner which he had originally painted four years earlier for the Ferrarese tailors' guild (see RUHMER, E., *op. cit.,* p.79), and in 1481 he was paid for 'la cunzadura de quattro tavole depincte cum quatro [sic] figure de femina ad olio' [the repair of four panels painted with four figures of women in oil]. These were to go with three newly painted nude female figures also in oil for the *studiolo* of Ercole I. see VENTURI, A., *op. cit.,* pp.26–7, and RUHMER, E., *op. cit.*, p.83.

46. See Notes 33 and 35 above. The full list of pigments used at Belriguardo corresponds closely to the palette used for 'An Allegorical Figure'. The pigments (in the order listed) were lead white [biacha], vermilion or cinnabar [zenaprio], a red lake [lacha fina], indigo [endego], red lead [minio], verdigris [verderamo], coarse and fine malachite [vedramo azuro grosso e sutile], lead-tin yellow [zanolino], two grades of azurite [azuro todescho] and two grades of ultramarine. The materials for gilding the stucco reliefs are also listed, including 8755 pieces of gold leaf! Tura is recorded as having gone to Venice in July 1469 to buy pigments and gold for Belriguardo. See VENTURI, A., *op. cit.*, p.14.

47. Deeply scored incised lines can often be seen on paintings by Tura, and in particular 'The Virgin and Child Enthroned' (No.772) where the complicated design of the decorated capitals has been incised into the gesso as well as the straight lines and arcs of the main architectural features. Incised lines have been noted as a feature of the X-radiographs of the two tondi, 'The Judgement of S. Maurelius' and 'The Martyrdom of S. Maurelius', in the Pinacoteca Nazionale, Ferrara. Some white lines visible in the architecture have been interpreted as having been drawn with a lead or silver point implement but they could equally well indicate incised lines which have been filled with subsequent layers of X-ray opaque paint. See BENTINI, J. (ed.), *op. cit.,* note 13, p.176.

48. Piero della Francesca's 'S. Michael' (No.769) which has been identified as having been painted with walnut oil (see MILLS, J.S. and WHITE, R., *op. cit.*, p.74) is part of the high altarpiece of S. Agostino in San Sepolcro for which Piero was contracted in 1454. However payments were still being made to him in 1469. See DAVIES, M., *op. cit.* (1961), p.430.

49. Alterations made by Tura to his other works in the National Gallery are relatively minor. For example, the green pilaster at the right edge of 'The Virgin and Child Enthroned' (No.772) was originally pink like that on the left, and X-radiographs reveal that the position of the owl in 'S. Jerome (Fragment)' (No.773) has been changed.

50. Later works like 'The Virgin and Child Enthroned' (No.772), although still painted in oil over tempera (see 'Analyses of Paint Media', p.94), show a thinner and more economical use of paint. Underdrawing is frequently visible even to the naked eye and the colours are usually lighter and more pastel in tonality.