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The cover shows
A detail of one of the leaves from the *Akbarnama*.
Photography by Michael Wheeler

Photography by Aya-san

The Nihonga mosha group.

a white pigment made from ground, weathered oyster shells. If made with the correct proportion of *nikawa* it produces a glowing, almost luminous white, but can only be seen once it dries, as it is transparent when in solution. This means that many trials must be made to obtain the depth necessary before brushing thin layers onto a painting. Most important of all I learned to layer *gofun* and malachite using the finest particle size first, then to build up with coarser layers, some so coarse they wore out the brush. It is the *gofun* and malachite pigments which are most prone to powdering and flaking.

The studio group consisted of four students, the Professor and his assistant, Uno-san, and me. Sometimes an American Professor of painting from Montana University joined us giving me a chance to speak English. There were days out when the group visited scroll mounters, karakami printers, papermakers or karaoke dives. Most of these outings were for my benefit, but the painting students enjoyed this extension to their education. To visit two papermaking villages we stayed overnight at a Ryokan, a traditional Japanese inn, where we ate and bathed together. We visited Mino, in Gifu-*Ken,* where the finest paper in Japan is made, and met Saioka-san who made the paper we used in the studio. We also visited Imadate, in Fukui-*Ken,* and watched vast sheets (approx. 2000 x 1000 mm) of indigo dyed *gampi* paper being formed.

I managed to visit many of the hundreds of temples in Kyoto and Nara, on my own at the weekends, and on Fridays with the History of Art department. I was able to survey at first hand the problem of paint loss which is widely evident.

The University is considering establishing a conservation school, and I hope my interest in the conservation of Japanese paint layers and papers was of use to them. I thank Miyamoto Sensei for all the information he gave me, I enjoyed my term in Kyoto very much, and hope to go back again one day.

Current Research

Back in England research is progressing in Paper Conservation into the consolidation of flaking and powdery matt gouache-type pigments on Japanese screens. A treatment has been developed for consolidant application which is less likely to disturb loose particles than application by brush, spray or air-brush. Building on systems devised at the Canadian Conservation Institute and the Getty Conservation Institute, this simple method allows a consolidant to be introduced gradually, within a humidity chamber, causing little or no colour change.

The small, inexpensive, plastic nebuliser will deliver an ulstrasonically produced mist from quite viscous liquids. Activated by a small air compressor, it is usefully mobile. Its potential in other areas of conservation is being explored, and further information will be available on completion of the research next year.

Painting in Japan

Sandra Grantham
Paper Conservation Research Student,
RCA/V&A Conservation Course

I am studying Japanese *byobu* and *fusuma.* These are the folding and sliding screens that were so important in Japanese life. My research will cover their history, and the papers and pigments used in their construction, paying particular attention to one of the conservation problems they present. This is the phenomenon of flaking and powdering of paint layers which often occurs.

The chance to spend time in Japan learning about the techniques and materials of traditional Japanese painting came in the first term of my second year of research. The Royal College of Art (RCA) and Kyoto City University of Art (KCUA or *Geidai* as it is known in Kyoto) operate a student exchange programme. Normally, this involves the exchange of fine art or design students. However, the relevance of the exchange to my own work was appreciated by both institutions and the scheme was extended to include me. I am grateful to Professor Frayling, now Rector of the RCA, for all his help.

Geidai does not have a conservation department (yet), but it gave me the chance to spend three months learning *Nihonga mosha.* That is copying classical Japanese scroll and screen paintings, an ancient tradition in Japan and also a way of prolonging the lifespan of a venerated painting. The opportunity to learn first hand the rudiments of the painting techniques and familiarise myself with the pigments and binders was immensely valuable to my research.

I tried to learn Japanese in the three months before my trip: this was spectacularly unsuccessful. When I arrived the culture shock was unexpectedly real. I felt as though I had become deaf and dumb. I could not read signs or understand a word. I would board a bus and just hope for the best. Life dropped to floor level: living, sleeping and working on the *tatami* mats, socks, no shoes. Eating was always an interesting excursion, sometimes not even being able to guess what I was chewing. But I did better than survive as the care and attention given to me by both students and tutors was generous and kind, unforgettable.

I thought that, having been a painter in the West, I would have the basic requirements needed to copy Japanese art. However, I had to learn to hold a brush, to size paper, to mix ink and to make paints from scratch, as none of the techniques were remotely like those I'd used before. It began with a trip, accompanied by my Professor, to colour merchants, where we sat for two hours choosing brushes, ink stick and stone, glue sticks and pigments which were weighed out by the gram, poured into glass phials and stoppered with paper lined corks.

I started with *sumi-e,* line drawing with black to grey ink. Without supporting arm or wrist, you guide the brush to make one stroke at a time, never going over a line a second time. I learned how to make the brush form particular marks and shapes. I copied from the *Choju Jimbutsu Giga,* a famous Heian period, twelfth century scroll from the *Kozan-ji* Temple in Kyoto. A scroll of biting social comment where all the characters are frogs, rabbits and monkeys. I did wonder, at one point, what I was doing on a mountainside in Japan drawing pictures of rabbits, but I persisted and learned how to manipulate a brush enough to want to learn calligraphy one day.

After five sections of the *Giga* were completed, Miyamoto Sensei, my Professor, allowed me to use colour. Not too many to start with, just indigo, gamboge and *benihana* (a crimson extracted from safflower petals). These colours are bought as *bo enogu* sticks- pigments mixed with *nikawa* (animal glue) and dried. They are reconstituted by rubbing the end with water and finger tip and collecting the colour in a small white porcelain dish. With these colours I learned 'boneless' painting where the colour defines the edges without any lines. I copied a plant painting from a scroll by Maruyama Okyo (1733-95).

The making of *gofun* paint involved several days of instruction. *Gofun* is

Editorial

Jonathan Ashley-Smith
Head of Conservation Department

The director of the V&A who had the foresight to select me as Head of Conservation 20 years ago, has just published his diaries for the years 1967- 87 (The Roy Strong Diaries). What was an extremely memorable day for me in November 1977 goes unremarked, but following my appointment, there is a succession of important events that we both seem to remember. Although his diaries deliberately concentrate on the social side of his life, he gives enough information to gain a good picture of the relationship between a Government and a National Museum. Most relevant today are observations about the effect of a change in government. Roy Strong remarks that a Conservative Government would be good for the Country but not for the Arts, yet the V&A suffered terrible cuts under a Labour administration. Indeed looking at the period covered by the diaries, which span two terms of Labour and two terms of Conservative control, one is left with the picture of a succession of politicians and civil servants with no sympathy for the short-term potential or the long-term needs of a major museum.

I have not yet met anyone in the museum profession who is not overjoyed at the recent change of government in this country. There seems to be no foundation for such joy. It is too early to know what effect, if any, a new government will have on museums and specifically on the conservation profession. One pre-election suggestion was that there would be an even greater emphasis on access to museum collections. Two means of achieving this were mentioned: first there should be no financial barrier to entering a museum. The ideology of free entry in the absence of adequate funding has led to the elimination of a meaningful conservation presence in Glasgow museums. At the recent British Museum conference- "The Interface Between Science and Conservation" it was remarked that the changes in Glasgow had, at a stroke, reduced the number of conservation scientists in Great Britain by ten percent. This loss affects **all** conservators and hence **all** collections in this country.

The second means of ensuring greater access is to take the objects to the people by means of travelling exhibitions. In his "Touring Exhibitions Manifesto" Julian Spalding remarks that touring exhibitions **are** museums. He explains that the science of conservation is there to provide "great improvements in both safety and accessibility", and the role of the conservator is "to find a way of doing what the organisers of touring exhibitions want". An increase in travelling exhibitions would seem to imply an increased need for conservators and conservation scientists. But throughout the country this is not the trend.

Individual museums may work out their own balance between preservation and access in the short term, but these two factors are only a part of the equation. To achieve balance in the relationship between income, access and preservation requires a long-term understanding between government and museum administrations about the continuing role of museums and their collections.

Managing to be "tackless"

Derek Balfour, Upholstery Conservator, Textiles Conservation
Simon Metcalf, Metalwork Conservator, Metalwork Conservation
Frances Collard, Assistant Curator, Furniture & Woodwork Department

Photography by V&A Photographic Studios

Figure 1. The Denon chair (1803-1813), belonging to the National Museums and Galleries on Merseyside, complete with upholstery.

The Denon chair (Figure 1) is one of a pair designed by Baron Dominique Vivant Denon and made by the celebrated firm of Jacob-Desmalter. The pair closely resemble a description of two chairs listed in the sale catalogue of Denon's collection after his death in 1827.

First documented in the 1917 sale catalogue of the Deepdene, home of Thomas Hope, the pair were subsequently sold at Christies in November 1995. The Victoria and Albert Museum and the National Museums and Galleries on Merseyside each purchased a chair through the Objection to Export of Works of Art procedure.

The frame of the chair is mahogany with brass inlay and ormoulu mounts (Figure 2). There was no physical evidence of original or early upholstery. The only documentation relating to the original top covers was Denon's use of grey wool for furnishing the room in which his chairs were placed. No information about the chairs when owned by Hope has yet been discovered. A search of French sources has not revealed any comparable chairs with original upholstery.

The two museums agreed that the Liverpool chair would be upholstered first and a fine grey wool and matching braid was chosen for the top cover. Eventually it may be possible to identify the original top cover and trimming and the present materials can then be replaced.

Conventional reupholstering generally involves attaching the various layers of materials to a wooden frame with upholstery tacks or staples, resulting in damage to the frame and loss of historic information. In the 1980s, in the USA, a method was developed that created the appearance of fixed upholstery, but without damaging the frame. Some treatments used a polyethylene foam, Ethafoam™ (Dow Chemical Company) and polyester wadding, others a combination of Ethafoam and loose fillings such as horsehair. The term "tackless" upholstery is often given to these methods. The aim of the treatment for these chairs was to re-create the upholstery using techniques and materials that were used at the time of manufacture, but based on the American idea.

The principles of this untacked reupholstery system are very simple. Secondary frames sit inside the existing framework. Metal plates are screwed to these frames

Photography by V&A Photographic Studios

Figure 2. The chair with the upholstery removed (85cm high, 65cm wide).

executed thick black lines which are clearly not original as they extend over an area of paint loss.

The mordant gilding on Christ's robe: A sample taken from the s-shaped fold on Christ's left side (where the gold border overlaps slightly with the textile and the ermine lining of the robe), showed a trace of red bole over the gesso, followed by a layer of lead white. The adhesive used to affix the gold leaf includes lead white and brown ochre pigments. These have probably been added both to tint the oil size or 'mordant' and to accelerate the drying process. The paint has split along both sides of the gold lines and, in places, across them. This is probably because the lead-containing, oil-based adhesive shrank causing cracking of the gold leaf on top and the paint layers below.

Christ's undergarment: A sample was taken from underneath Christ's upper left arm. The extreme variation in tone on Christ's undergarment suggests the use of a lake pigment and some fading. The sample shows two layers of mid-toned pink paint which were probably executed with a mixture of two different types of red lake. One pigment fluoresced a bright orange-pink under uv illumination which is characteristic of madder lake; the other is probably of insect origin, such as kermes or lac.

The Virgin's robe: A sample was taken from the right of the arrow-shaped shadow at the extreme left of the skirt. The true colour of the Virgin's robe is hidden by two layers of discoloured varnish. It would originally have been a very pale lilac colour and the cross-section showed that this was achieved by tinting lead white with azurite, madder lake and another lake which did not fluoresce under ultra-violet light. This is a technique which Cennini mentions: "And if you wish to clothe Our Lady with a purple, make the drapery white, shaded with a little violet so very light that it is just off white."

The mordant gilding on the Virgin's robe: A sample taken from the left fold at the foot of the robe again revealed an oil size tinted with ochre but in this case it seems to contain little, if any, lead white. This may explain why the gold leaf has not split.

The lining of the Virgin's robe: Of the three samples taken, one was from below the Virgin's right elbow and another from where the lining is visible on her shoulder. The lining now appears black, but was actually once a bright green with a raised black floral pattern. The pattern is visible in raking light and shows up very clearly with infra-red reflectography. A sample taken from the pattern on the lining showed a complex layer structure. Silver leaf has been applied on top of the gesso ground with an oil size tinted with ochre. This has then been glazed with what seems to be a verdigris layer and two coats of clear green copper resinate or oleate glaze. A sample taken through one of the lines of the floral pattern showed that this is composed of a mixture of lead white and carbon black. A layer of copper resinate or oleate glaze was also identified on the border of the Virgin's crown.

Flesh tone of the Virgin's hand: A sample taken from the Virgin's left hand, just above her wrist, showed the typical technique for painting flesh at the time. The underpaint of the flesh is composed of green earth, lead white and a little yellow lake. Verdaccio, consisting of vermilion, a little carbon black and possibly lead white has been applied to the areas of shadow. The layer of pink flesh colour has been obtained by mixing lead white and vermilion.

The samples taken from Christ's blue robe and from the Virgin's lining revealed a faint, grey layer over the final pigment layer which may represent an earlier or original egg white glair applied to protect the surface. It is also evident that the *Coronation* had been varnished at least twice with an oil varnish.

Overall the pigment analysis suggests that a great deal of colour change has taken place on the *Coronation* affecting the brilliance of the panel. The pigments used are typical of the works of the di Cione brothers and indeed of paintings of the period.

The examinations of the *Coronation of the Virgin* as a whole give a valuable insight into the production of this type of work. They are also useful in piecing together the original appearance of works of this period.

References/Notes

1. I would like to thank colleagues and friends who gave their help and support with this research.

2. The pigment results are a summary of Jo Darrah's findings: *An Examination of the Materials and Techniques of the Coronation of the Virgin,* Internal V&A Conservation Research Report, September 1996.

3. Bomford *et al. Art in the Making: Italian Painting Before 1400,* National Gallery, 1990, p136, Figure 95.

4. *Ibid.* "either because the ink was very dilute or because something like an iron-gall ink was used.", p176.

5. Cennino d'Andrea Cennini, *The Craftsman's Handbook "Il Libro Dell'Arte",* Dover, 1960, p93.

Gilding

A combination of incised lines and punching has been used to decorate the haloes and the Virgin's crown. It is interesting to note that the haloes have been punched with a series of simple circular punches but more complex floral punches and a granular punch have been used for the crown. This discrepancy may reflect a simple desire on the part of the workshop to distinguish between the haloes and the crown. Alternatively, it may be that the punchwork was executed in two stages using two different sets of punch tools, not necessarily from the same workshop.

The panel includes various *pentimenti* - changes of mind - presumably on the part of the painter. The *pentimento* on the Virgin's profile is a particularly good example (Figure 4). Stereo microscopy revealed an additional incised line which was originally intended to be the outline of the Virgin's chin and mouth. This is very clear underneath her chin where the gilder has stippled up to the original line. The incised line curves upwards and protrudes approximately 5mm beyond the new painted line of the chin. It then curves in and out again forming the original line of the lips. This may reflect a decision made during the course of painting, to widen the gap between the bottom of the nose and top of the lips and to enlarge the chin.

Underdrawing and painting

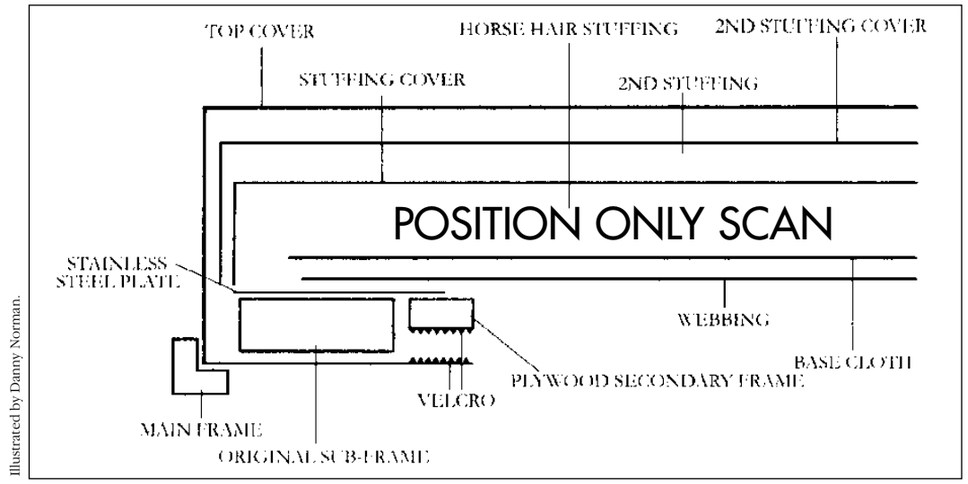
Very faint lines of underdrawing are visible at the neck and waistline of the Christ figure where the paint layers have become transparent. These lines are scratchy and characteristic of a quill pen. Unfortunately, infra-red reflectography used to examine them further did not show any underdrawing. This does not necessarily mean that none is present, but simply that the underdrawing could have been executed with a material containing little or no carbon.[3]

Paint samples were taken and made into cross-sections. These were analysed using incident illumination and incident polarised illumination at X100 to X500 magnification and with ultra-violet illumination at X250 magnification.

Christ's ultramarine robe: A sample from just below Christ's hip revealed an underpaint composed of lead white, carbon (perhaps bone black), and a little dark red-brown ochre. This would have resulted in a purplish-grey tone which would deepen and enhance the blue of the ultramarine, a pigment of great translucency. The unmodulated ultramarine was then applied. The modelling was achieved by black hatching in the shadows. The hatching is quite dense in parts, and consists of two types of lines. The majority of these are faint fluid lines which seem to be original. There are, however, some crudely

Photography by V&A Photographic Studio.

Figure 4. Detail of the *Coronation*



Illustrated by Danny Norman.

Illustration 1. Cross-section showing frame and upholstery structure.

and overlap the parts of the frame to which the original upholstery was tacked. The subsequent layers of upholstery are attached to this basic structure. Each unit is removable, leaving the chair void of upholstery for close examination (Illustration 1).

Senior Furniture Conservator Tim Hayes made three secondary frames. One frame was required for the drop-in seat and one each for the inside and outside back upholstery. These were cut with a small allowance for movement from 17mm birch ply.

A simple technique was required for making the metal plates. For wide use and to reduce future corrosion problems, the aim was to avoid welding or soldering of elements and to use the most inert metal available, stainless steel. Avesta Sheffield, a major stainless steel manufacturer was contacted for advice. An austenitic stainless steel was selected (L316 grade), the prime constituents being iron, chromium, nickel, molybdenum and carbon. Obtaining the metal in small quantities proved difficult. The minimum order price is usually about £150 which buys two sheets 1m x 2m x 1mm.

Accurate templates are crucial. Melinex™ (Imperial Chemical Industries Ltd) and card were used for this and from which the metal plates were cut using mechanical shears. The shapes were then finely adjusted with hand files. It was important to use clean tools to avoid contamination of the stainless steel (steel filings or wire wool would cause rusting).

The curved top of the inside back plate was formed using a raw hide mallet, tapered mandril and the flat of an anvil. Templates of the curve on the back of the chair were made using plastic coated 5mm electrical wire. With such curved pieces we found the lower edge of the plate had to be longer than originally anticpated, to give the finished frame enough clearance to hook over the chair carcass.

When the plates were completed they were date-stamped and attached to the secondary frame, using stainless steel screws to avoid galvanic corrosion. Holes, 2mm in diameter, were drilled at 10mm intervals at a constant 10mm from the edge, to allow the textiles to be attached. Large holes meant fewer broken drill bits and made the stitching easier. The sharp edges were chamfered and each hole countersunk from both sides. Finally, the metal surfaces were cleaned using acetone (Figure 3).

Photography by Derek Balfour

Figure 3. The drop-in seat with the secondary frame and metalwork complete; ready for the upholstery.

The Upholstery

Before beginning to create the upholstery, the edge of the metal had cotton ticking folded over it and stitched in place, through the holes. Webbing and a linen base cloth were stapled to the secondary frame. A filling of curled horsehair was added and enclosed in scrim (an open woven linen). The scrim was turned under and pinned to the cotton ticking before being firmly stitched to the ticking.

To retain the seat profile three rows of twine stitches were formed through the stuffing. These pass from the side walls, through the stuffing, and out on to the top surface. A row of blanket stitch, along the top edge, was added to create a very sharp line in the final profile. A second stuffing of horsehair was added and the whole seat enclosed in fine linen, also stitched to the cotton ticking (Figure 4).

Photography by Derek Balfour

Figure 4. Completed under-upholstery awaiting the top cover.

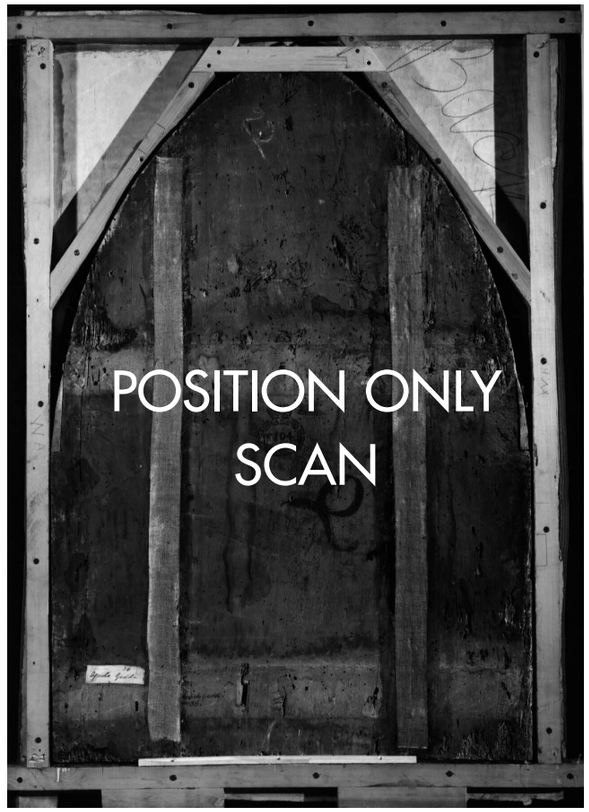
In order to retain the curve around the front of the seat, the top cover was made with a border. The underside was made in four sections. These form flaps that pass under the original drop-in seat frame and attach to the underside of the secondary frame with hook and loop fastenings, Velcro™ (Selectus). The Velcro allows the cover to be released and the whole of the seat upholstery to be removed.

The basic principles and construction for the inside back are similar to the seat. However, the unit is attached by hooking it over the top rail of the chair. It simply hangs in place.

The outside back had to appear as a simple rectangle of fabric tacked flat to the frame; it does not have any filling. The same basic plywood and stainless steel unit was made to which the top cover fabric was stitched, adding the trimming around the edges. This unit is attached to the frame by four tabs of Velcro which are stapled to new frame sections (these were replaced before the chairs came to the Museum). The outside back is fitted into the chair before the inside back unit is in position.

Conclusions

Only minor adjustments were necessary to the original treatment proposal and it was possible to prevent the frame from sustaining additional damage. The chair appears to be conventionally upholstered, unless examined from the underside of the seat. The co-operation between the conservators and the curators was very productive and contributed greatly to the very successful result.



Photography by V&A Photographic Studio.

Figure 2. The back of the *Coronation*

function as the centre panel of an altarpiece, its size would have had to accommodate lateral panels which might well have depicted full length saints. A study of the iconography in fourteenth century Italian panel painting indicates that the composition of the *Coronation* would have been unlikely to terminate just below the Virgin and Child but would have included another element. This need not have been musical angels as has been suggested, but perhaps a continuing expanse of the elaborate textile. Given the above evidence it is reasonable to conclude that the panel is missing a significant section from its bottom half.

As well as being cut down at the bottom, the shape of the panel may have been changed entirely. There is insufficient space to consider the arguements here, but again there is physical and iconographic evidence that the rounded arch may originally have been a rectangle, triangle or trapezium. The later inserts of a different timber at the "shoulders" of the panel would have been applied after the panel was modified (Figure 3).

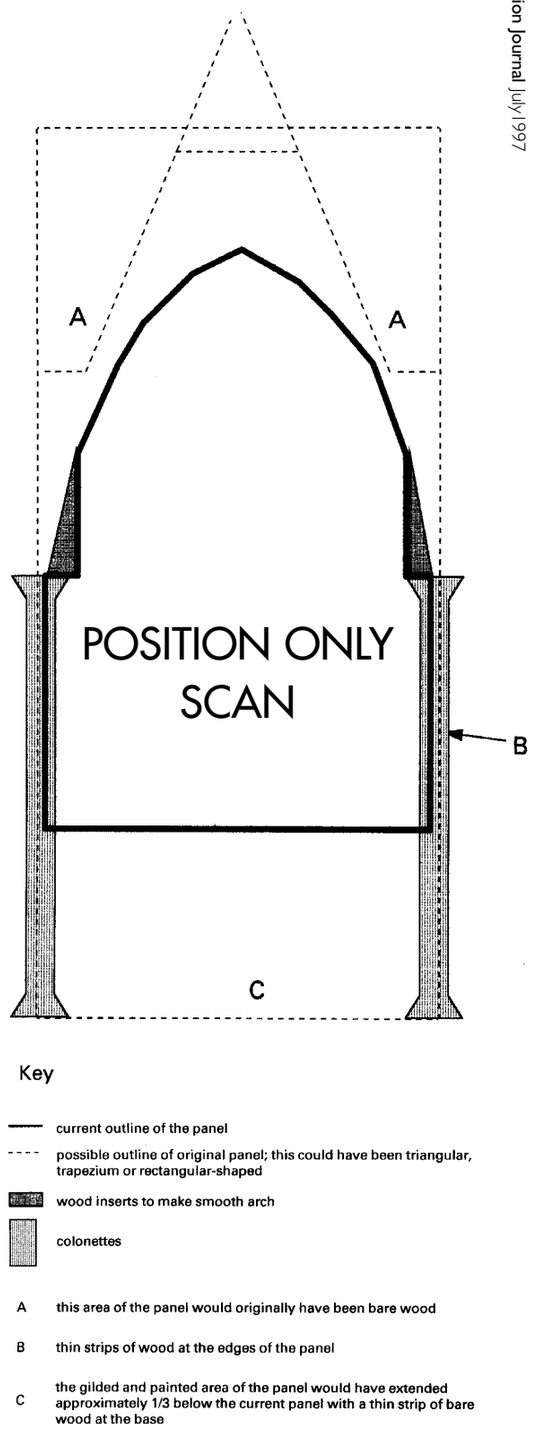
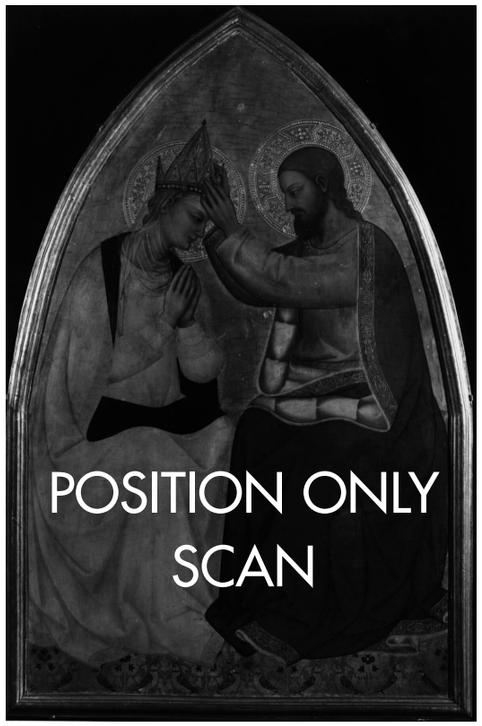


Figure 3. Stylised reconstruction of the original shape of the *Coronation*

The Coronation of the Virgin - a technical study

Katharine Hugh
Curatorial Assistant, Apsley House, The Wellington Museum

The *Coronation of the Virgin,* Museum No. CAI 104 (Figure 1)[1], is attributed to Nardo di Cione, one of the leading artists of mid-fourteenth century Florence. There is no surviving documentation on the panel and therefore the attribution and dating are based upon style. In July 1996 the *Coronation* was investigated using a range of techniques including examination by incident and raking light, stereo microscopy, x-radiography, infra-red reflectography and ultra-violet illumination (uv). Paint samples were also taken and examined[2]. This paper presents the initial findings and highlights some of the interesting aspects of the panel's production. A subsequent paper will bring together technical, stylistic and iconographic evidence in the consideration of the panel's attribution and dating.



Photography by V&A Photographic Studio.

Figure 1. *The Coronation of the Virgin,* Museum No. CAI 104.

Nardo di Cione was one of four artistic brothers. Andrea di Cione, known as Orcagna, is the more renowned. Nardo matriculated in the *Arte dei Medici e Speziali* in Florence in 1343. He may have trained in the workshop of Bernardo Daddi and shared a workshop with one or more of his brothers at a later date. His best-known work is the *Last Judgement, Paradise,* and *Hell* cycle on the walls of the Strozzi Chapel in S. Maria Novella in Florence. As his will of 21 May 1365 was executed on 16 May 1366, he must have died by that date.

Structure, original size and shape of the panel

The panel is composed of three vertical butt-joined poplar members and measures 118cm x 77.5cm. The frame is nineteenth century and has been applied to the surface of the panel edges reducing the sight-size to 110.5cm x 70.5cm. Two wooden butterfly joins are visible in the bottom half of the x-radiograph and must have been inserted to reinforce the joins. As they are not visible at all on the back of the panel, they must be part of its original construction (Figure 2). Although we now see the *Coronation* displayed as a single panel, it would originally have formed part of a multi-panelled altarpiece. Two marks and nail-holes on the back of the panel show where battens would have been attached to reinforce the joins in the panel and secure it to lateral panels at each side. The x-radiograph reveals the characteristic irregular shape of a medieval nail remaining in one of the holes. This indicates that the marks almost certainly correspond to the position of original battens.

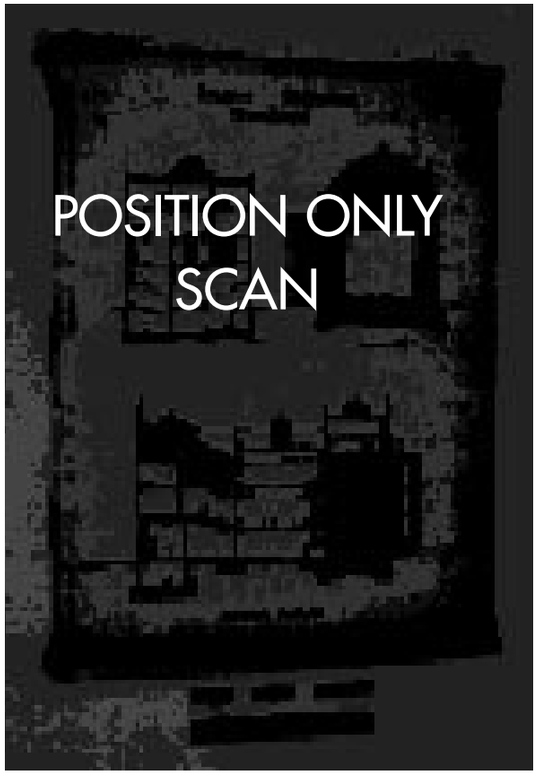
Even as a single panel the *Coronation* is undoubtedly incomplete. As with many extant medieval works, it has been cut down, changing its original size and shape. There is physical and iconographic evidence for this. Proportionally, the panel looks wrong; the arch starts approximately half-way up from the base. However, on other panels of the period the arch generally begins about two-thirds of the way up from the base. The bottom batten mark on the back of the painting also appears too low relative to the base of the panel, as do the butterfly joins. Furthermore, in view of the panel's likely

The initial conservation of an archive of rolled architectural drawings

Jane Rowlands
Contract Paper Conservator (January - June 1996), Paper Conservation

This article outlines a six month project dealing with badly damaged archive material. It describes the size, condition and treatment of the archive and addresses some of the problems associated with salvage projects.

The archive represents almost all the remaining drawings produced by the firm of Frank Matcham (1854 -1920)[1] the most prolific theatre architect of his generation (Figure 1). Although many of his theatres have been demolished those still standing include the London Coliseum, Buxton Opera House, the Grand Theatre, Douglas and Harrogate New Kursaal. Within the archive are examples of all the major types of drawing and printing used by architects at this time, illustrating every stage of work.



Photography by Jane Rowlands

Figure 1. A drawing for the Grand Theatre Woolwich.

Provenance, size and condition

The archive was moved from the firm's offices some 40 years ago to a barn. About three years ago when the barn was cleared out, the archive was recognised as being of significance. The Theatre Museum subsequently acquired the archive of 139 rolls amounting to between 9,000 and 10,000 drawings.

Eighty-four of the rolls had mould damage, mainly confined to one end (Figure 2). The extent of this mould damage is linked to the degradation of the material. There was heavy surface dirt and the roll ends were crumpled and torn; however smaller drawings within were found to be very well preserved.

The project aimed to make the archive accessible for accessioning and cataloguing. This involved the compilation of a condition survey and initial catalogue, remedial conservation treatments and the upgrading of storage.

Photography by Jane Rowlands

Figure 2. Mould damaged edge of one roll end.

Documentation

Prior to the contract a preliminary catalogue and condition survey were carried out by Pauline Webber and Phillipa Hunt from Paper Conservation. During the early stages of the contract two separate documentation systems were developed, a card file system and a survey form. The card file system enabled an overall

view of the progress of the project. Basic information on each roll was recorded, including location, treatment and drawings of significant interest.

It was necessary to have a record of each drawing's location within its roll. Each drawing has an individual entry and took about three minutes to document. The survey addressed general questions about the archive and provided more specific information about particular damage to material types (Table 1).

The treatment for each item was documented using another single line, tick box form.

Type	Drawing or print method
Number	Number in the roll
Category	Condition rating 1-4, to integrate with other Museum surveys
Condition	Summary of damage
FM	Produced by Matcham's office
Other Maker	Name of other maker
Place	Address of maker
Date	The most recent was noted
Size	Largest dimensions
Other Information	Title or anything significant

Table 1. Outline of the documentation for each drawing.

Treatment

The rolls with mould damage were isolated and treatment began on the remaining 55 rolls. It was decided early on to flatten as many drawings as possible. This would reduce the risk of further damage during cataloguing and enable a longer term storage system to be devised. Damage to the rolls without mould was physical rather than chemical and they could be opened without humidification. Drawings were only brushed or surface cleaned if there was a lot of dust present. The amount of moisture introduced before pressing varied considerably, dictated by the substrate rather than the media. Only one ink was found to be fugitive. Some points of interest are outlined below.

- Linen lined drawings on Whatman® paper responded best if sprayed on the verso only. This allowed the linen and adhesive longer to absorb moisture than the paper and created a more even 'relaxation'.
- Different types of tracing paper responded differently to moisture, some papers became pliant, while others cockled badly. Therefore, some sheets were treated locally with water and then eased flat, others only required pressing for a long period, while some responded well to humidification in an ultrasonic humidity chamber.
- Oil impregnated papers of different types were noted. Creased and folded areas were particularly brittle but a line of water brushed along the inside of the fold rehydrated the area and could then be eased flat. Whole sheets were placed on blotting paper and sprayed lightly with water. Polythene was smoothed onto the drawing and a weight applied. The impermeable layer above the object allowed the blotting paper to draw the moisture through the substrate.
- Opaque linens reacted to moisture in a similar manner to cotton rag paper.
- The image on tracing linens appears on the matt side. Water was applied locally in creased and folded areas as spraying resulted in cockling and irretrievable loss of gloss.
- Blueprints and dyelines are both created using a sensitized photographic coating[2] and responded similarly. Moisture was applied to the verso allowing it to penetrate and humidify the paper before the photographic coating.

After completing the first section of the archive, I began to remove mould spores from the 89 rolls, in a fume cabinet. It was interesting to note which materials had been attacked by the mould; in some cases the paper had been all but destroyed while its linen lining was unaffected.

Storage

A simple, relatively inexpensive flat storage system has been devised. Up to 12 drawings will be placed in polyester film 'L-velopes' (welded along an adjacent short and long edge) and divided every third drawing with a sheet of neutral pH paper (due to the pH sensitivity of the photographic prints). Outsize drawings are to be stored rolled following T.K. McClintock's system of rolled polyester sleeves.[3] Suitable shelving has been located and the whole bay will become a container; the shelves will be enclosed by attaching and folding down Tyvek®. In July 1996 the system was approved but implementation required funding.

Brief discussion

Before undertaking to collect and conserve large, badly damaged archives certain considerations need to be taken into account. These include the condition and number of objects, the space and time available, what treatment level is expected/required and the documentation of material prior to accessioning.

The Fascicule

A piece of *Kingami* paper, the same weight as the object, is attached to the verso along the left hand side of the object using wheat starch paste. A small tab of *Kingami* is attached to the centre of the right hand edge of the object to help with the turning of the page. This may still stress the object but is much safer than turning the page by holding the page. The edges of the *Kingami* papers were feathered to minimise contact with the object.

A wide strip of lighter weight Japanese paper, *Kozo Hosokawa,* was attached to the left hand strip of *Kingami* to allow flexibility when turning the page. A sheet of *Bunkoshi* paper, to act as a support sheet when turning the leaf, was pasted to the *Kozo Hosokawa* using a thin strip of the same paper. This thin strip was then attached to the verso of the fascicule. Finally, the excess of the wide strip was pasted to the backboard of the mount to become a hinge (Figure 3).

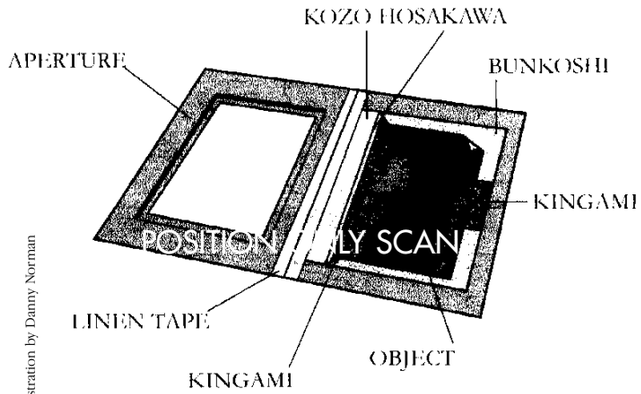


Illustration by Danny Norman

Figure 3. Fascicule system used for the mounting of the *Akbarnama*.

The aperture of the mount is cut from Museum Board (6-ply). This slightly covers (clips) the edge of the object, but allows the edge of the miniature painting to be clearly seen. To ensure that the aperture does not rub against the surface of the object, another 6-ply board aperture is cut slightly larger than the object then attached to the back of the first aperture. This adds depth and ensures that when the mount is closed there is no pressure, from the top aperture, on to the pigments' surface. The second aperture surrounds the object but does not actually touch it leaving the object to move quite comfortably inside the mount. A lid of Museum Board (2-ply) is attached to the mount to further protect the miniature during storage. This can be folded back behind the mount when the object is in a frame (Figure 4).

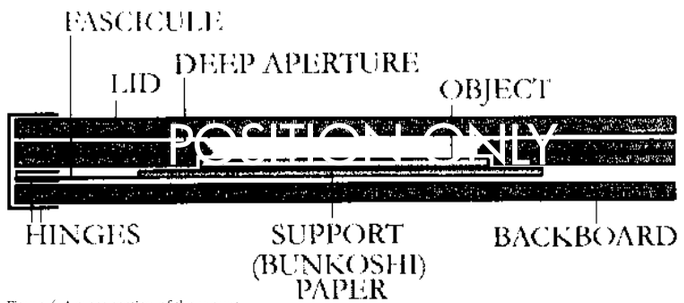


Figure 4. A cross-section of the mount.

Illustration by Danny Norman

When the *Akbarnama* is returned to storage, a sheet of Museum Board (2-ply) will be placed in the top of each Solander box. This will be placed over the the aperture of the open window mount to prevent the object falling through the aperture when it is turned over to view the verso.

Acknowledgements

Sue Stronge, Divia Patel, Jo Darrah, Merryl Huxtable, Helen Lindsay, Danny Norman, Pauline Webber.

Materials and Suppliers

- Methyl Cellulose (low viscosity type, 2% aqueous solution at 20 °C, 337.5-630CP) and Wheat Starch Paste, BDH Laboratory Supplies, Poole, BH15 1TD.
- *Bunkoshi* and *Kingami* Paper supplied by Falkiners Fine Papers, 76 Southampton Row, London WC1 4AR.
- *Kozo Hosokawa* paper from Masumi Corporation, 4-5-2 Sugamo, Tokyo 170, Japan.
- Museum Board supplied by John Purcell, 15 Rumsey Road, London SW9 OTR.

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1. Clarkson, C., and Lindsay, H., Housing single sheet material: The development of the fascicule system at the Bodleian Library, *The Paper Conservator* 18, 1994, p40-48.

caused at the selected concentration. The consolidant was applied by brush whilst viewing the paint surface with a low power binocular microscope. The very dilute nature of the methyl cellulose necessitated multiple applications.

Powdery surfaces presented more of a problem when applying the methyl cellulose. It was difficult not to disturb the pigment residue. It is hoped to alleviate this problem in the future by applying consolidant with an ultrasonic humidifier or by using a micro syringe.

The brown paper patches were removed with poultices of methyl cellulose and water, or with very moderate local applications of steam. Care was taken to only use the minimum amount of moisture to allow the removal of the repairs and thus prevent undue cockling of the pages.

Insect damage, splits and tears were reinforced on the verso of the sheet using thin Japanese paper. This was toned with watercolour beforehand and adhered with wheat starch paste. Insect channels were filled with macerated Japanese paper fibres mixed with wheat starch paste. Only the most unsightly repairs were removed, as often the tonality of existing repairs could be modified with watercolour or pastel. In all cases, inpainting was confined to fills or repairs, and no reconstruction of missing areas was attempted.

In a few cases where the cockling and distortion were sufficient to interfere with the appreciation of the miniature flattening of the pages was attempted. Gradual humidification was carried out using either a Gore-tex™ (W.L.Gore & Associates Inc.) and blotting paper sandwich, or by suspending the page over a bath of cold water on a nylon mesh support. In several cases, humidification resulted in slight concavity of the page after flattening in the press . This was considered more visibly acceptable than the localised cockling

Mounting and Presentation

In 1996 a survey of the housing condition of the *Akbarnama* miniatures revealed the following;

- All of the mounts clipped the edges of the paintings causing abrasion of the pigments, especially when the works were stacked in piles and stored in Solander boxes.
- Many of the objects were cockled and had risen above the apertures of their mounts causing the pigments to rub against the backboard of the mount above.
- The variety of hingeing methods used made it difficult to turn the pages and view the back of the manuscript.
- Most of the materials were not of a recognised conservation standard.

After consultation with the Indian and South East Asian Department, it was decided that the treatment carried out should be kept to a minimum and that the mounting system should not disguise the fact that the miniatures were originally part of a bound manuscript. For this reason, it was decided inappropriate to inlay individual pages, in the technique usually associated with the mounting of watercolours and single sheet drawings. Furthermore, the guard strips along the spine edges were left in position as proof that the objects were fixed originally into the binding.

When choosing the mounting system the points raised in the survey were considered. It was fundamental that the object could be viewed easily without causing any damage. The mount had to be deep enough to ensure that the painting did not rise above the aperture whilst allowing for the possibility of further cockling. The apertures needed to be enlarged to reveal more of the recto and allow the inscriptions around the edges to be read without raising the mount. This is especially important when the object is displayed in a frame. Finally all the materials used for rehousing must be approved conservation materials of a known composition.

A fascicule, adapted to our own requirements, seemed the most suitable method of attachment into the mount. The fascicule was introduced by Christopher Clarkson[1] at the Bodleian Library to describe the method of single sheet material attachment into a bound format. After many experiments with a variety of materials, it was decided that Japanese mulberry papers of varying weights, attached using wheat starch paste produced a strong and flexible hinge to support the leaves.

It is important to state that the fascicule method selected for the mounting of the *Akbarnama* represents a very particular solution which both conservators and curators agreed was sympathetic to the history and format of the objects. It is the most appropriate method for objects which are usually stored horizontally, but is not necessarily recommended for Indian miniatures which are to be displayed in frames for long periods of time (for which the tabs of Japanese paper along the top edge are the safest method of hingeing).

The restraints of space and time should not be underestimated. Enough space is needed for rolls to be opened and worked on without restriction: a dedicated workspace should be available. To maximise efficiency the time allocated for conservation work should be divided so that streamlined systems can be established.

In addition to assessing the physical condition of the archive for conservation purposes and identifying the material for the cataloguer, a record of specific drawing order may have significance, and as such, should form part of the documentation.

Assessment

Adaptations to treatment were necessary for processing large numbers of drawings. Time spent at the beginning, determining the rapid and effective introduction of moisture reduced the actual working time. Time and material costs were saved by not interleaving during treatment. Finally humidification and flattening of objects facilitated surface cleaning and did not reduce the effectiveness of the procedure.

It was possible to document and flatten all of the 55 rolls without mould damage. These rolls, amounting to 4,000 drawings are now flat stored (Figure 3). In addition approximately 40 were repaired and linen tape was removed from a further 50. The mould was dusted from 37 of the remaining rolls, 16 of which were then humidified and pressed.

Documentation enabled a catalogue to be compiled that would draw attention to points of particular interest. Most of the ground work has been completed and preliminary cataloguing was carried out.

Photography by Jane Rowlands

Figure 3. The finished archive in flat storage.

A dramatic improvement has been made in the state of the archive, not only physically but also in the increased accessibility to historical information.

Conclusion and closing remarks

Frank Matcham was and is an architect of national importance and until this archive came to light little was known of his working method. It had been thought that Matcham gave overall directions but had no detailed concern with his buildings; this archive presents very strong evidence to the contrary.

The archive shows the variety and diversity of architectural drawings. They are important for a number of reasons, not least because they come from and trace the development of Matcham's office. They also show the development of architectural drawings, their uses and the development of twentieth century building practices.

The project enabled a sustained period of work to be carried out and did more than fulfill the initial aim. Some drawings have already been made available to architects working on renovation or restoration projects, specifically the London Palladium. It is possible, with the right space, facilities, aims and single-minded approach, to collect and treat this type of salvage material and to make significant improvements to its condition.

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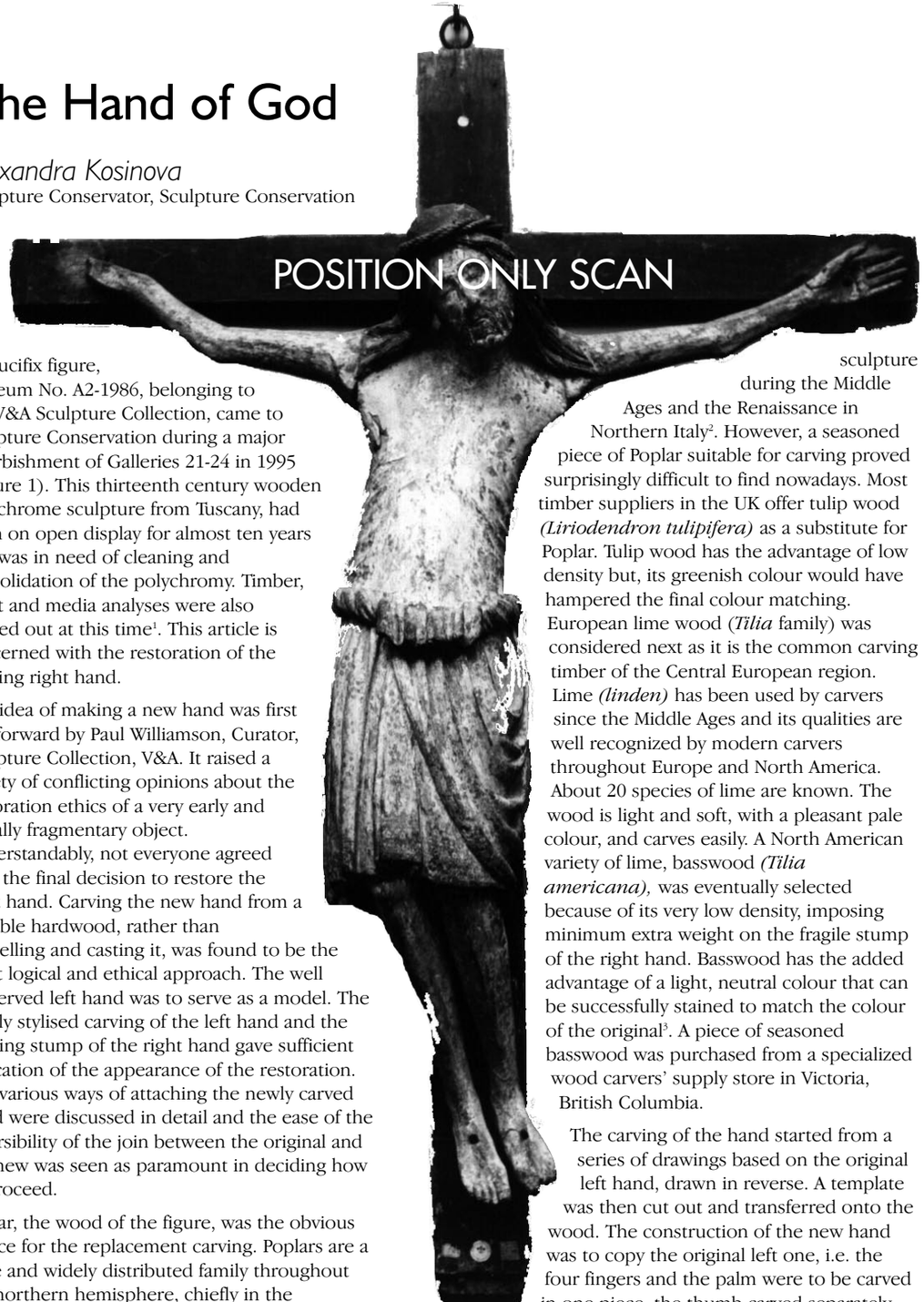
The Hand of God

Alexandra Kosinova
Sculpture Conservator, Sculpture Conservation



Photography by V&A Photographic Studio

A Crucifix figure, Museum No. A2-1986, belonging to the V&A Sculpture Collection, came to Sculpture Conservation during a major refurbishment of Galleries 21-24 in 1995 (Figure 1). This thirteenth century wooden polychrome sculpture from Tuscany, had been on open display for almost ten years and was in need of cleaning and consolidation of the polychromy. Timber, paint and media analyses were also carried out at this time[1]. This article is concerned with the restoration of the missing right hand.

The idea of making a new hand was first put forward by Paul Williamson, Curator, Sculpture Collection, V&A. It raised a variety of conflicting opinions about the restoration ethics of a very early and visually fragmentary object. Understandably, not everyone agreed with the final decision to restore the right hand. Carving the new hand from a suitable hardwood, rather than modelling and casting it, was found to be the most logical and ethical approach. The well preserved left hand was to serve as a model. The highly stylised carving of the left hand and the existing stump of the right hand gave sufficient indication of the appearance of the restoration. The various ways of attaching the newly carved hand were discussed in detail and the ease of the reversibility of the join between the original and the new was seen as paramount in deciding how to proceed.

Poplar, the wood of the figure, was the obvious choice for the replacement carving. Poplars are a large and widely distributed family throughout the northern hemisphere, chiefly in the temperate zone. They are fast growing, short lived trees. The wood is soft, with inconspicuous growth rings and light in weight. It is used as building timber, and for veneer and pulp. Poplar was the wood most commonly used for wooden sculpture during the Middle Ages and the Renaissance in Northern Italy[2]. However, a seasoned piece of Poplar suitable for carving proved surprisingly difficult to find nowadays. Most timber suppliers in the UK offer tulip wood *(Liriodendron tulipifera)* as a substitute for Poplar. Tulip wood has the advantage of low density but, its greenish colour would have hampered the final colour matching. European lime wood (*Tilia* family) was considered next as it is the common carving timber of the Central European region. Lime *(linden)* has been used by carvers since the Middle Ages and its qualities are well recognized by modern carvers throughout Europe and North America. About 20 species of lime are known. The wood is light and soft, with a pleasant pale colour, and carves easily. A North American variety of lime, basswood *(Tilia americana),* was eventually selected because of its very low density, imposing minimum extra weight on the fragile stump of the right hand. Basswood has the added advantage of a light, neutral colour that can be successfully stained to match the colour of the original[3]. A piece of seasoned basswood was purchased from a specialized wood carvers' supply store in Victoria, British Columbia.

Figure 1. Crucifix on display before conservation and restoration (207cm high, 180cm wide).

The carving of the hand started from a series of drawings based on the original left hand, drawn in reverse. A template was then cut out and transferred onto the wood. The construction of the new hand was to copy the original left one, i.e. the four fingers and the palm were to be carved in one piece, the thumb carved separately and fitted on afterwards. However, the existing stump, roughly one half of the right palm, also had to be accommodated. The palm and the four fingers were carved first, with the measurements

Figure 2. The *Akbarnama* on display in the Mughal Room of the South Kensington Indian Museum.

Structure and Condition of the *Akbarnama* pages before treatment

The leaves of the manuscript are made up of a laminate of three sheets of paper. They have been highly burnished and surface sized with starch. The miniature paintings and the leaves are an integral whole, rather than the painting being "set into" (inlaid) the sheet. The miniatures are painted in opaque pigments in a gum arabic medium, and in many cases the colours have been burnished. In some areas of pigment loss it is possible to see traces of underdrawing in black chalk.

The paintings are surrounded by a border of ruled lines in opaque watercolour and the lower margins contain notes in Persian. The verso of each sheet contains a text panel. The leaves of the written manuscript are of a different thickness to the leaves with full page illustrations.

When the pages were removed from the binding in 1896, the paper guards along the spine edges were left in place. The pages were mounted with a very wide range of acidic boards and papers. Both the recto and verso of the object were disfigured by unsympathetic repairs of brown paper and glassine tape. Also there were many edge tears, holes and channels resulting from attack by furniture beetle. In some cases the repairs on the recto extend into the image area causing unsightly distractions and others where the repairs mask important inscriptions in the margins.

Many of the miniatures showed signs of flaking paint and powdering of pigments, as well as surface marks caused by abrasion. The thick layers of pigment were very prone to cracking, especially in cases where the surface had been burnished. The white pigment used for the painting of the faces seems to have been particularly prone to flaking and loss: due to lack of adhesion to the burnished pigment underneath, lack of binding medium when the paint was applied, or because a thick layer of paint had been applied on top of a thinner paint.

The range of pigments identified include Indian yellow, vermillion, iron oxide red, malachite, azurite, indigo, and carmine lake. Verdigris has not been found on the *Akbarnama* miniatures examined to date. Even though all of the miniatures were out on display from 1932-1955, there is apparently very little fading of the colours . This is probably a result of the use of relatively thick layers of pigment and binder compared to the transparent watercolours in western paintings.

Consolidation and Repair

An aqeuous solution of methyl cellulose (0.5% weight per unit volume), with a few drops of alcohol, was selected as the consolidant. Methyl cellulose of a relatively low viscosity was chosen because the refractive index of the paint surface was least effected and no visible surface gloss was

Conservation and mounting of leaves from the *Akbarnama*

Michael Wheeler
Senior Paper Conservator, Paper Conservation

Clair Battisson
Conservation Mounter, Paper Conservation

The *Akbarnama* is a remarkable work of 116 miniature paintings and is noted for its minute detail. The manuscript gives a picture of the emperor Akbar's life and times, in both text and illustrations. The illustrations are not merely entertaining but are of unique documentary value. The high degree of modelling of the figures and the realistic recession of the landscape towards the horizon is evidence of the influence of European art, as this is common in the western painting of this period.

The Victoria and Albert Museum holds a substantial part of what is thought to be the first presentation volume of the text and attracts interest from researchers and scholars world-wide. For this reason it has been designated as an object of exceptional cultural value within the V&A's collections and has been selected as a priority for treatment.

Background

Akbar was born in Pakistan in 1543 and inherited the throne at the age of thirteen, on the death of his father, Humayan. Humayan had met two Iranian master artists, Mir Sayyid Ali and Abdus Samad, during his exile and they subsequently joined his service: they later directed the painting studio under Akbar. Their first major project was the *Hamzanama* manuscript but the *Akbarnama* was begun in 1569 and probably completed by 1590.

The illustrated manuscript was bought by the South Kensington Museum (now the V&A) in 1896 from Mrs Frances Clarke (Figure 1). It had been acquired by her husband upon his retirement from serving as Commissioner of Oudh (1858-1862).

Shortly after 1896, the paintings and illuminated frontispiece were removed from the volume to be mounted and framed for display. Clarke wrote a report for the Museum pointing out that the paintings carried attributions to the leading painters of the reign of Akbar and that the manuscript had a number of seals and inscriptions. Some of the seals and endorsements are from the period of the emperor Jahangir and later his grandson, Aurangzeb. The *Akbarnama* was displayed in its entirety in the Mughal Room of the South Kensington Indian Museum (an annex of the V&A) from 1936 until 1955 (Figure 2).

Photography by Michael Wheeler.

Figure 1. A leaf from *Akbarnama* album (377mm x 250mm).

Photography by Alexandra Kosinova

Figure 2. Detail of the restored right hand.

taken with callipers from the left hand.
The spaces between the four fingers were initially cut with a saw, copying the technique used on the left hand. After cutting with the saw, the spaces between the fingers were further worked with a chisel. The new hand was then cut into two pieces to fit around the original stump. The first piece included half of the palm with the forefinger, the middle finger and the ring finger. A dowel was made from the same wood to fit the existing hole, left by the previous restoration, where a ring finger would have been. A matching hole was drilled into the newly carved ring finger, the dowel was inserted in place and the whole piece was adhered with a mixture of poly(vinyl acetate) emulsion, wood dust and whiting. The same mixture was also employed as a filler in the gaps. The second piece was the little finger attached with a basswood dowel. The dowel fitted into the existing hole in the stump and a hole drilled in the new little finger. The same adhesive/filler was used. The thumb was carved from another piece of basswood with the help of callipers only. It was adhered to the newly carved part of the palm with poly(vinyl acetate) emulsion, without having to stick it to the original. The same filler was used for the gaps.

The details of the carving, such as the fingernails of the thumb, were completed after the hand was assembled. The options for the visual integration were discussed with the Curator at this point. It was obvious that the very pale basswood needed to be colour matched. At the same time it was felt that for ethical reasons the restoration should not be completely disguised by retouching.
A compromise was reached, of sealing and staining the hand. The wood was sealed with lemon shellac in ethanol and stained by acrylic based wood stains. Further adjusting of the colour was achieved with watercolours (Figure 2).

The Crucifix is now back on display in Gallery 22. The restoration has, at least for some, brought more unity to the object and made it more appreciable (Figure 3).

Acknowledgements

I am grateful to Paul Williamson for his ideas and support throughout this project. My thanks also extend to Albert Neher from Furniture and Woodwork Conservation Section for his advice on staining wood.

References

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2. Kosinova, A., article submitted for publication by the UKIC.

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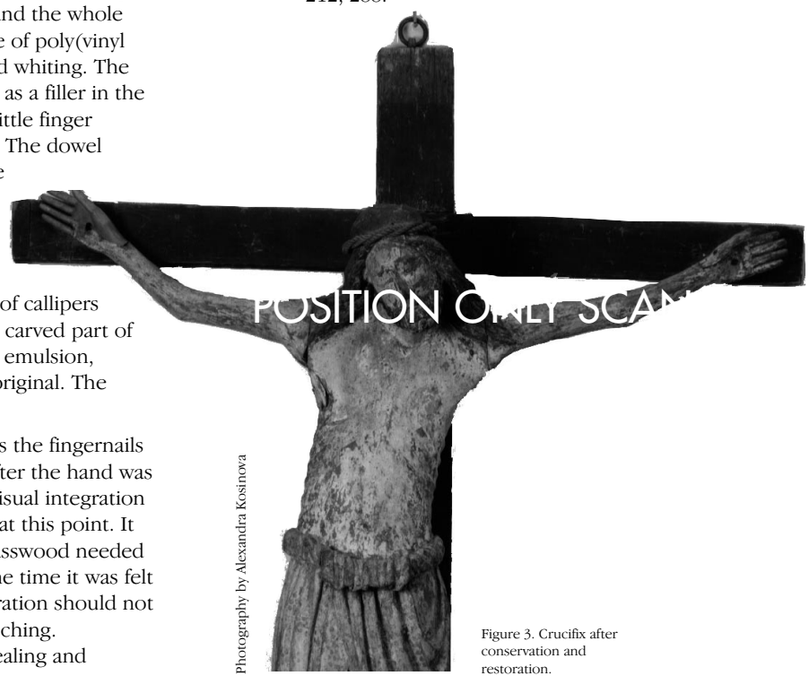

Photography by Alexandra Kosinova

Figure 3. Crucifix after conservation and restoration.

The Conservation of Nineteenth Century Dissected Puzzles

Alison Norton
Paper Conservator, Paper and Book Conservation

This project was carried out as the final part of an MA in Paper Conservation at Camberwell College of Arts. It was completed in November 1996, shortly before I began working at the Victoria and Albert Museum.

Jigsaws are popular with both institutional and private collectors yet little work had previously been completed concerning their preservation and care. The purpose of the project was to examine the problems associated with this type of composite object and to provide an initial framework for their conservation.

Dissected puzzles, or jigsaws as they came to be known after 1870, originated in eighteenth century England and quickly became very popular toys. The earliest puzzles were high quality items; however changes in the nineteenth century involved the use of poorer materials and the puzzles tend to have deteriorated to a great extent. Wooden pieces were phased out in the twentieth century and so this project focused on nineteenth century puzzles, of which numerous examples survive. The jigsaws usually comprise of wooden puzzle pieces onto which hand coloured prints on paper were adhered. They were housed in wooden boxes of sliding lid construction with a varnished image glued to the lid (Figure 1). Often paper 'key pictures' were also included to serve as a guide to the completed puzzle.

Figure 1. View of partially opened box showing an 1870 map jigsaw puzzle of England and Wales.

Survey and Condition

Initially a survey was developed to determine the extent and nature of deterioration patterns to the puzzles. This was carried out on the nineteenth century jigsaw collection at the National Museum of Childhood, Bethnal Green (NMC). The survey results revealed the forms of typical damage, and was accompanied by information gained from the Benevolent Society of Dissectologists, a group of jigsaw puzzle enthusiasts. Damage originates from two main areas - the nature of the materials used and the function of the puzzles as children's toys - and included warping of the wood, discoloured and deteriorated paper, cracked and yellowed varnish, abrasion, losses of entire pieces as well as parts, considerable surface dirt, accretions, previous repairs and biological damage.

Four puzzles were individually worked on, to illustrate how their conservation could be approached. One of these came from the NMC and the others from the Jill Grey Collection in Hitchin, Hertfordshire. The jigsaws ranged in date and varied in size and quality, all displaying different problems. The NMC puzzle (1855) was double-sided and still had its key pictures. It had been repaired previously with pressure sensitive tape. The first puzzle from Hitchin was a small jigsaw of a Mother Goose pantomime figure and was dated 1806. The other two were maps - one of Asia (1840) and one of England and Wales (1870).

Conservation Ethics

Jigsaws are primarily ephemeral objects and this affected their conservation requirements. Social history collections are reflections of people and deal with everyday things. Since the importance of objects as sources of information cannot be overestimated the treatment ethics were necessarily of minimal intervention throughout. The unity of a puzzle is found in its combination of materials and any deliberate tampering with this would spoil and negate the 'value' to researchers and collectors. Thus separation of the layers was to be avoided, in keeping with the central tenet of preserving the original nature of the jigsaws. Moisture was also to be kept to a minimum since any such treatment would have introduced the risk of severe distortion to the original, as paper and wood have different dimensional responses. The puzzles from Hitchin would eventually form part of a 'living historical centre of education' where objects could be readily handled, and to accommodate this requirement facsimile copies of the puzzles were produced using computer digital imaging technology. This further enabled preservation and minimal treatment to be the primary goals of treatment.

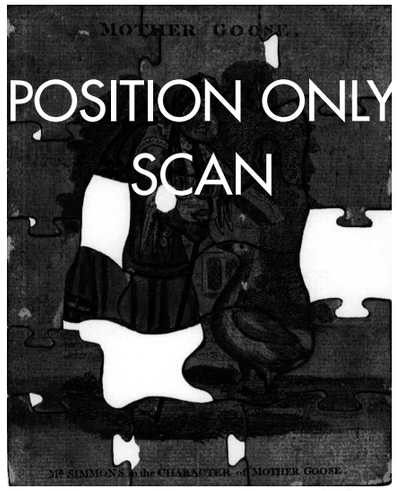

Figure 2. Copy of the original scanned image of an 1806 jigsaw puzzle of Mother Goose before digital manipulation.

Conservation Treatment

All jigsaws are made to be used and surface soiling and embedded dirt was to be expected. The paper layers of the puzzles were dry mechanically cleaned. Loose dirt was brushed away and the wooden boxes were cleaned using cotton wool swabs, distilled water and Synperonic N, a non-ionic detergent. Swabbing was also used to remove grime from the varnished paper layers on the box lids. The varnish on the lids was discoloured and damaged but despite the craquelure it was decided to retain the original finish. The underlying paper layer was however protected with localised applications of gelatine in the necessary areas.

Previous repairs were removed where these were damaging to the object. The pressure sensitive tape on one of the puzzles was mechanically removed. After tape removal and the fixing of some small fugitive ink inscriptions the key pictures were washed. They were then repaired and lined using *kozu shi* Japanese paper and L4 lens tissue with wheat starch paste.

It is very common for jigsaws to have numerous losses of both entire pieces and of the interlocking tabs. The replacement of these missing areas was necessary to give the objects mechanical stability and also aesthetic coherence. The repairs were made using jelutong - *dyera costulata* - a wood from Southeast Asia and archivally approved western papers individually chosen for each puzzle. The wood repairs, shaped using a powered fret-saw (Vibrosaw 2000), were adhered using rabbit skin glue. A mixture of wheat and potato starch paste was used to adhere the paper layer; this was to reduce the moisture content and improve the bonding abilities. The repairs were toned using watercolours. One of the puzzle boxes had been damaged by woodworm and was structurally very weak. These losses were infilled using a mixture of rabbit skin glue and lycopodium (spores from the club foot moss of the genus *lycopodium clavatum*), which was then toned to match the surrounding wood. The project also considered the interaction of paper and wood, structural distortion of the puzzles and designed storage and housing solutions.

Making the facsimiles

The making of copies has a tradition almost as old as art itself and the role of the facsimile puzzles was central to this project. The jigsaws were scanned into a computer and the resultant digital images were manipulated using an image processing programme, Adobe Photoshop™ (Adobe), in effect producing 'on-screen restoration' (Figures 2 and 3). The final images were printed onto archival quality paper and used in the construction and cutting of duplicate puzzles. The use of the facsimiles demonstrates the huge potential of the application of computer technology to conservation and the wider museum field, and was accompanied by a simple computer game based on the jigsaws' images.

Conclusion

The project was beneficial in extending the working life of the puzzles through structural and aesthetic improvements, increased stability and a potentially greater educational profile. Many objects are of composite materials and increasingly collections include multimedia works of art, and the conservation treatments proposed could be of wider application on objects for which separation is not an option.

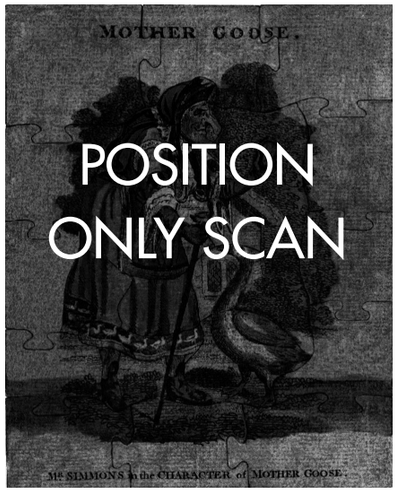

Figure 3. Copy of the scanned image of the jigsaw after digital manipulation, enhancement and image completion.

Acknowledgements

I am grateful to Camberwell College of Arts, Fiona Doddswell, curator of the Jill Grey Collection, the staff of the National Museum of Childhood, Bethnal Green, and the Paper and Book Conservation Sections.