SUMMARY The painting of Death of the Buddha (1913,0501,0.40) has probably never been on display at the British Museum since it was acquired in 1913 due to its poor condition at that time. This fifteenth-century Buddhist painting was recently fully conserved and remounted as a hanging scroll. What is known of the painting’s history is explained and its condition before treatment is described as background to a full account of the entire treatment process. The successful conservation and mounting of a complex painting on silk as a hanging scroll requires a great number of treatment stages, each involving hundreds of careful steps. The overall procedure is here dealt with in three categories: conservation, mounting and the scientific analysis that helped to inform the treatment.

Introduction

The ‘Collaborative Project for the Conservation of Japanese Paintings’ in the British Museum is a joint project between the British Museum and the Association for Conservation of National Treasures (ACNT: Kokuho Shuri Sokoshi Renmei) supported by funding from the Sumitomo Foundation. It was established in 2007 with the aim of conserving a series of important Japanese scroll and screen paintings in the British Museum’s collection. By March 2014 a total of 12 conservators from six conservation studios in Japan had participated in this project for a total of 301 days in 22 stages. At each stage they have worked alongside British Museum conservators in the Hirayama Studio, which is home to the Eastern Art on Paper and Silk Section of the Department of Conservation and Scientific Research. To date, five paintings have been fully conserved and remounted and two paintings are currently undergoing conservation.

This contribution focuses on the painting Death of the Buddha (1913,0501,0.40), the treatment of which was started in 2008 and completed in 2013 as part of the Collaborative Project, Figure 1. After examining the painting’s history and condition prior to conservation, the treatment process is dealt with in three sections: conservation, mounting and the scientific analysis that helped to inform the treatment. The processes have been separated in this way to illustrate the different approaches taken during the conservation of this painting. To produce a fluent account of the treatment process, detailed technical information relating to individual procedures, and to the preparation and application of materials, is presented separately in a technical appendix. It is hoped that this appendix will provide a useful reference point for those who wish to understand the details of this highly specialized conservation discipline in depth. As with all conservation treatments, while the principles outlined here may extend to analogous paintings, the individual practical stages were subject to a careful decision-making process and were specific to this complex painting.

Death of the Buddha

The painting shows the parinirvana, or entry into a state of complete enlightenment, of the historical Buddha, Sakyamuni, which is popularly referred to as the ‘death of the Buddha’. Sakyamuni is depicted lying on a jewelled dais, his head resting on his right arm, his body slightly bent and surrounded by mourning bodhisattvas, disciples and animals. At the top right a group of figures headed by Anaritsusonja and Sakyamuni’s mother, Maya, descend on a cloud. The commemoration of
the death of the Buddha is the most spiritually profound event of the Buddhist calendar. It is marked annually with special ceremonies (nehan-e) and readings of sutras on the fifteenth day of the second month. Large paintings are known to have been used as the focus of worship in such ceremonies since at least the Nara period (AD 710–794).

The British Museum painting has traditionally been attributed to Awataguchi Takamitsu, who worked in the early fifteenth century, specializing in Buddhist subjects. He is thought to have been the third son of Tosa Mitsuaki (fl. c.1345–1375). Although this attribution is no longer maintained, the painting has the brilliant colouring and fine attention to detail of traditional Tosa school painting (painting in Japanese Yamato-e court style) of the fifteenth century. Acquired by the British Museum in 1913, Death of the Buddha has probably never been on display over the last 100 years due to its poor condition at that time. The importance of this painting was first recognized in 1996 by Professor Miyajima Shin’ichi, then a Senior Specialist for Cultural Properties in the Japanese Agency for Cultural Affairs (Bunkacho). Professor Miyajima recommended that it be included as a possible candidate for repair under the ‘Conservation of Works of Japanese

Figure 1. Death of the Buddha before treatment (left) and after treatment (right). Before treatment: painting 712 (w) × 1357 (h) mm, mount 867 × 1912 mm. After treatment: painting 714 × 1363 mm, mount 932 × 2290 mm
Art in Foreign Collections’ scheme that was then being run by the Bunkacho, Japan Foundation and Tokyo National Research Institute for Cultural Properties.

**Condition before treatment**

The painting was in a critical condition both structurally and aesthetically. The hanging scroll mount was no longer functioning as intended, since it neither protected nor embellished the painting. An initial assessment using reflected, raking and transmitted light, as well as microscopy, provided considerable information on the condition of the painting, Figure 2.

The silk substrate was found to be delaminating from its lining paper across the entire painting, rather than simply along creases or in areas of loss, indicating that adhesion between the silk and lining paper had greatly deteriorated. Dark brown silk reinforcement strips (c. 4–5 mm wide) that had been attached directly to the verso of the silk substrate were contributing to the detachment of the original silk. This delamination alone placed the painting in a perilous condition.

In addition, there were many areas of missing silk, most of which revealed reverse painting (pigments applied to the verso of the silk, termed wazaishiki) that had transferred onto the first lining. Using a Leica M651 surgical microscope fitted with a digital camera it was confirmed that in several areas that were unpainted on the recto, reverse painting could still be seen through the silk weave on the first lining, Figure 3. This implied that the first lining paper had already been reused in the past, but that it had not been realigned exactly. It was thus anticipated that much of the reverse painting would detach with the lining paper and that the position of pigments on the silk and lining paper would differ.

In general, the pigmented areas were stable, exhibiting neither flaking nor powdering, but there were some passages of white paint that showed a colour change to silvery grey.

![Figure 2. Details of damage: (a) creases, delamination of the silk substrate, silk reinforcement strips and altered white pigment; (b) creases, delamination and old inpainting; (c) loss of the silk substrate and reverse painting on the lining paper; and (d) reverse painting remaining on the lining paper](image1)

![Figure 3. Detail of an area of the painting where blue pigment is present on the lining paper but not on the silk substrate (left) and a view of the silk and lining paper in this area under higher magnification (right)](image2)
and a few areas of earlier loss, mainly where red and white pigments had been applied over a malachite-containing green paint. Additionally, some inexpert inpainting in the blue region at the top of the painting was visually distracting.

Small black dots seen all over the painting both on the silk and lining were thought to be old mould, while stains on the right side showed the scroll to have suffered from earlier water damage.

The old first lining was relatively pale and, as it could be seen through the open-weave silk substrate, appeared to desaturate the colours of the painting. The pale lining also exaggerated the appearance of the dark silk reinforcement strips.

There were many creases across the entire painting and mount. The dark blue mount silk was badly degraded, probably because of the use of an iron-based mordant during dyeing, and the silk fabric had tears immediately under the hanging stave (top stave, hyomoku) on both sides. The proportions of the mount seemed inappropriate for the dimensions of the painting, as both the inner border (chuberi) and outer border (soberi) appeared too small. Finally, there was delamination of the final backing and the left metal roller knob (kanajiku) was missing.

**Painting and mount: structure and treatment history**

Some aspects of the structure and history of the painting and mount were identified during the initial examination, while others were revealed during treatment.

The painting was executed on painting silk (eginu), a plain weave silk that has not been degummed, so that sericin still surrounds the fibroin. The threads lie in pairs and the weave is relatively open, which made it possible for the artist to use the reverse painting technique (in Death of the Buddha most of the painted areas have paint on the verso as well as the recto). It may have been painted while the silk was stretched on a frame and would have been lined and mounted soon after completion. The colourants used for the painting were traditional natural pigments and dyes commonly used in Japan and the later removal of the lining papers provided an opportunity to carry out non-invasive pigment analysis using X-ray fluorescence (XRF) and Raman spectroscopy, the results of which are described below. The binder is most likely to have been an animal glue, but this could not be confirmed by analysis.

The painting was mounted as a hanging scroll in a Buddhist-style mount, with a faded red and gold brocade for the inner border and a dark blue damask for the outer border, Table 1. The painting measured 712 × 1357 mm and the overall mount size was 867 × 1912 mm. It was joined to the mount fabrics by means of mounting strips (narrow strips of lined silk or paper: *suji*); the inner mounting strips that join the painting and inner border were of white paper while the outer mounting strips that join the inner and outer borders were dark blue silk. The mounting strips overlapped the mount fabrics by 3 mm, leaving a 2 mm narrow strip visible between the component pieces, as shown in Table 1.

During treatment it became apparent that the painting was supported by three layers of lining paper since, at some point, two *kazo* (*Broussonetia kazinoki* Siebold) paper linings had been applied to the painting before it was assembled into a hanging scroll with mount fabrics and the final backing attached.

The old first lining, attached directly to the painting, consisted of 15 pieces of paper. It is assumed that 12 rectangular sheets, each measuring 385 × 270 mm, were knife cut to create straight edges (bōtsugi) and joined to form a continuous roll that...
was placed across the painting so that lengths could be cut to match its width.¹ Five and a half rows of joined paper made up was placed across the painting so that lengths could be cut to match its width.¹ Five and a half rows of joined paper made up to the length of the painting, i.e. vertical.

The second lining was also kozo paper with the paper fibre direction perpendicular to that of the first lining. This paper appeared to be more recent than the first lining and the component sheet size was smaller (342 × 227 mm). There were also some paper reinforcement strips (oribuse) between the second lining and the final backing; these were presumably part of an earlier treatment that had attempted to remedy creases in the painting.

The final backing was also kozo paper, with an individual sheet size of 464 × 297 mm. Again the sheets were formed into a roll before use, but on this occasion each sheet showed feathered (water-cut) edges. The top part of the backing was not the usual protective silk (uwamakiginu) but blue paper dyed with indigo. The overall backing paper seemed to be more recent than the second lining and thus considerably newer than the first lining. The thickness and fibre direction of all the linings in the old mount are presented in Table 2.

It is not clear how many times this fifteenth-century Buddhist painting has been remounted or how the original mount appeared. From their condition in comparison to the original silk substrate, it can be assumed that neither the old mount fabrics nor the old first lining are original. Furthermore, it seems likely that the painting was already in this poor condition when it was acquired in the early twentieth century. It is possible, therefore, that this painting has not been remounted for nearly two centuries.

Whatever the painting’s conservation history, certain features of these previous treatments can be deduced. As mentioned previously, the shifted reverse painting pigments (urazaishiki) prove that the old first lining was reused in a past remounting and that it was reapplied after narrow silk strips were attached directly to the painting’s verso over cracks. Additionally, pigments from some inexpert inpainting were noted to have leached through the lining papers, showing that the mount fabrics had also been reused. As the final backing appears newer than the other linings it can be assumed that during the most recent mounting treatment only the final backing was replaced (perhaps after applying paper reinforcement strips), without further disassembly of the painting and mount fabrics.

**Treatment objectives**

When lining papers are weak, damaged or aesthetically disfiguring, they will usually need to be replaced. It is because of this periodic relining that many silk paintings have survived hundreds of years in a hanging scroll format. However, this fifteenth-century painting could not be treated in a straightforward fashion and a detailed understanding of its condition and structure was crucial in formulating the treatment objectives. Had the first lining paper been in good condition it would have been reused, but the lining paper was badly damaged, particularly where it was in contact with copper-containing green and blue pigments such as malachite (ryokusho) and azurite (gunjo). Similarly, had the adhesion between the silk substrate and the first lining been stronger, keeping the first lining in place would have been an option, but delamination was a major issue. As importantly, the silk strips applied directly to the verso of the silk substrate had to be removed as they were causing its delamination. Close visual observation suggested that the reverse painting would detach during the lining paper removal, so methods for reattaching the pigment had to be formulated. Another complication was relocating the transferred pigment, since the linings had previously been shifted into a slightly different position.

Prior to the conservation and mounting treatment, the following treatment objectives were formulated and discussed:

- Replace the delaminating first lining paper with dyed kozo paper to provide fundamental support for the original painting on silk.
- Preserve and reattach to the verso of the silk the reverse painting pigments that had transferred to the first lining.
- Infill missing silk to provide stability for the painting.
- Apply paper reinforcement strips over tears and creases to help prevent future creasing.

### Table 2. Details of the lining papers used for the old mount

<table>
<thead>
<tr>
<th></th>
<th>First lining</th>
<th>Second lining</th>
<th>Third lining</th>
<th>Fourth lining</th>
<th>Nakaura</th>
<th>Final backing</th>
<th>Thickness after mounting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inner border (Chuben)</td>
<td>Kozo</td>
<td>Kozo</td>
<td></td>
<td>n/a</td>
<td>n/a</td>
<td>Kozo</td>
<td>0.50–0.60 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.07 mm</td>
<td>0.075 mm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Outer border (Soben)</td>
<td>Kozo</td>
<td></td>
<td></td>
<td>n/a</td>
<td>n/a</td>
<td>Kozo</td>
<td>0.55–0.60 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>0.05 mm</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Note

The ↓ symbol indicates that the paper fibre direction of the lining paper is parallel to the length of the painting and mount and the ↔ symbol that the paper fibre direction of the lining paper is perpendicular to the length of the painting and mount.
Remount the painting with new silk fabrics in suitable proportions to provide stability and an appropriate aesthetic for the painting.

Store the painting with a wooden roller clamp (futomaki) around the roller rod in a paulownia box.²

### Treatment process

It is not straightforward to separate the conservation treatment of an East Asian painting from its remounting, since when presented as a hanging scroll, hand scroll or folding screen, the painting and its mount constitute a single unit, in contrast to most easel paintings, which are set in detachable

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### Table 3. Summary of the stages of treatment and analysis carried out on Death of the Buddha

<table>
<thead>
<tr>
<th>Conservation treatment</th>
<th>Mounting treatment</th>
<th>Scientific analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1. Examination and record keeping</td>
<td>M1. Disassembly</td>
<td>S1. Technical imaging</td>
</tr>
<tr>
<td>C2. Capillary washing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3. Consolidation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C4. Silk substrate repair</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C5. Facing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C6. Lining removal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C7. Facing removal and application of first lining</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C8. Application of paper reinforcement strips</td>
<td>M2. Subsidiary linings</td>
<td>S2. Pigment analysis</td>
</tr>
<tr>
<td>C10. Storage</td>
<td>M4. Assembling</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M5. Backing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M6. Final drying of the mounted painting</td>
<td></td>
</tr>
<tr>
<td></td>
<td>M7. Finishing</td>
<td></td>
</tr>
</tbody>
</table>

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![Figure 4. Stages of the treatment process: (a) before treatment; (b) after capillary washing; (c) in transmitted light; (d) old second lining; (e) old first lining; (f) verso after lining removal; (g) after first lining; (h) verso after paper reinforcement strip application; (i) before inpainting; and (j) after treatment](image)

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² Keisuke Sugiyama, Tim Clark, Janet Ambers and Giovanni Verri
The study and conservation of the silk painting *Death of the Buddha* frames [1]. The conservation of Japanese paintings is, therefore, firmly rooted in scroll mounting techniques, and while it can be argued that standards of Japanese scroll mounting reached their pinnacle many years ago, the conservation techniques applied to paintings have nevertheless greatly improved over recent years. To demonstrate the interplay of conservation and mounting techniques – and the role of scientific examination and analysis – in the treatment of *Death of the Buddha*, the various steps in this complex procedure are set out in Table 3. In the text that follows, these steps are grouped according to the thematic headings in Table 3 rather than in strict chronological order.

### Conservation of the painting

#### Examination and record keeping

The condition and structure of the painting were examined extensively before treatment. Images of the whole painting and mount, and details of areas of damage, were made in visible light using a Hasselblad 503CW camera with a digital back. In addition, infrared reflected, infrared false colour, infrared reflectographic and ultraviolet-induced luminescence imaging were carried out. The silk substrate and pigments were examined under a surgical microscope to identify a similarly woven silk for repairs and to test the fugitivity and solubility of the pigments. These observations and images were used to ensure that all areas of damage were recorded on a damage map and to assist in the production of life-size diagrams on tracing paper that indicated where pigments had shifted position.

#### Capillary washing

Although it was necessary to reattach the fragile delaminating silk substrate to the lining temporarily with *funori* (a seaweed gel) before further treatment, the painting medium was stable enough to allow capillary washing prior to consolidation, Figure 4. In this way it was possible to avoid consolidating dirt along with the original pigments. As the mount was not particularly thick, the final backing was not removed at this stage. The painting was placed onto several layers of blotting paper and water applied to both the recto and verso with a so-called Dahlia sprayer. Spraying was repeated several times, mainly from the front, and the water could be seen gradually to penetrate into the painting so that the soluble dirt was absorbed into the blotting paper; the blotting papers were changed when necessary.

The painting was dried between layers of polyester sheet, blotting paper and felt with gentle pressure applied by wooden boards under weights. Before the painting had completely dried, it was attached to a karibari drying board to allow it to dry and flatten under tension.

#### Consolidation

The painting did not have unstable pigments, but because of the potential for future degradation of the binding medium and mechanical stress from repeated rolling and unrolling of the hanging scroll it was decided to consolidate all the pigments by applying high quality rabbit skin glue with a small brush. A 3% solution in water was used for areas containing azurite or malachite and a 2% solution for the other pigments. The consolidation process was repeated twice while the painting was stretched on the karibari drying board. Later in the treatment, after lining removal, a 2% aqueous rabbit skin glue solution was applied to the reverse painting pigments on the verso of the painting.

#### Silk substrate repair

For repair, an aged plain weave silk with a weave similar to that of the original silk substrate was selected from the many samples held by the ACNT. Some of the repair silk was dyed with alder cone dye, from *Alnus firma* Siebold et Zucc. (known as *yasha* or *yashabushi*) with potassium carbonate as a mordant. This silk was lined

### Table 4. The materials used in the different stages of the facing process

<table>
<thead>
<tr>
<th>Layer</th>
<th>Material</th>
<th>Image of the process</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>12 g.m⁻² Rayon paper 150 × 120 mm 60 sheets ↔</td>
<td><img src="https://example.com/image1" alt="Image 1" /></td>
</tr>
<tr>
<td>Second</td>
<td>12 g.m⁻² Rayon paper 900 × 1500 mm 1 sheet ↓</td>
<td><img src="https://example.com/image2" alt="Image 2" /></td>
</tr>
<tr>
<td>Third</td>
<td>18 g.m⁻² Rayon paper 750 × 900 mm 2 sheets ↔</td>
<td><img src="https://example.com/image3" alt="Image 3" /></td>
</tr>
<tr>
<td>Fourth</td>
<td>18 g.m⁻² Rayon paper 900 × 1500 mm 1 sheet ↓</td>
<td><img src="https://example.com/image4" alt="Image 4" /></td>
</tr>
<tr>
<td>Fifth</td>
<td>20 g.m⁻² Sanmoa 900 × 1500 mm 1 sheet ↓</td>
<td><img src="https://example.com/image5" alt="Image 5" /></td>
</tr>
</tbody>
</table>

Note: The ↓ symbol indicates that the paper fibre direction of the facing layer is parallel to the length of the painting and mount and the ↔ symbol that the paper fibre direction of the facing layer is perpendicular to the length of the painting and mount.
temporarily with kozo paper using funori and flattened under tension on a drying board.

Infilling of losses in the silk substrate was carried out in two different campaigns during treatment of the painting. To protect the original reverse painting pigments that had transferred to the first lining and had been exposed where the silk substrate had been lost, repair silk was used to infill losses from the recto. The repair silk was cut to fit losses exactly using two methods, either by tracing the area of loss with a fine pencil and then trimming the silk on a cutting mat or by cutting directly over the loss using thick Melinex sheets as a barrier. The repair silk infills were set into the losses and attached to the lining paper from the painting’s recto by applying funori to both the temporarily lined repair silk and the lining paper behind the loss. The temporary lining paper was then removed from the infill.

After the painting had been faced temporarily and the first lining removed, a second campaign of infilling the remaining areas of silk loss was carried out from the verso. For complex-shaped losses, lined silk was used in the same way as it had been when working from the recto. For simpler losses, patches of unlined silk were applied using funori. The weave of this silk had previously been ‘set straight’ with funori and had been left to dry on a sheet of Perspex. After the infills had dried, the overlapping edges were trimmed with a blade to the exact shape of the loss.
Facing

Although facing supports may have been used during Japanese mounting procedures in the past, the following specific technique of facing a painting to facilitate lining removal and infilling appears to have been established quite recently [2].

After the painting had been humidified by spraying and brushing with water, five layers of facing sheet were applied to its surface, using 12 g.m⁻² rayon paper, 18 g.m⁻² rayon paper and Sanmoa, as listed in Table 4 and using the funori solutions detailed in the technical appendix. The first, second and third layers of facing were brushed directly onto the painting with funori while the fourth and fifth layers were instead pre-adhered to each other on a lacquer bench before they were applied. The newly faced painting was left on a felt bed for four hours until it was semi-dry and then dried completely by pasting its edges to a karibari drying board. Once dry it was removed and applied face inwards onto a rigid sheet of Perspex, the edges of which were covered with kozo paper adhered with thick wheat starch paste.

Lining removal

The final backing was removed using gentle humidification. The mount was covered with a few layers of Sanmoa followed by moderately moistened thick rayon papers and a plastic sheet (for more information on this technique see Naito and Usami [3]). It was at this point that the second lining was discovered and also removed.

Removal of the first lining commenced after the facing treatment. Using a thin funori solution, a temporary support of 12 g.m⁻² rayon paper was adhered to each piece of the old first lining that was to be taken off. Some areas of the first lining at the top of the painting were extremely difficult to remove because the paper was very weak, so these areas were ‘skinned’ instead of being completely removed. The old first lining papers were dried flat and a representative sheet was used for pigment analysis, as described below.

At this stage remaining areas of missing silk were infilled from the verso as described above. Where the old first lining paper carried some original pigments, these areas were cut out. Each section was then carefully and appropriately repositioned around areas that were more heavily pigmented (to ensure stability). The safe execution of this crucial lining stage requires great expertise and long practice since the silk substrate does not have any substantial support at the time of lining.

Facing removal and application of the first lining

Prior to applying the first lining, four of five facing layers were removed by moistening with a spray and brushing with water, leaving only the first facing layer attached directly to the painting’s surface. With each layer that was removed the painting expanded a little, so it was then lifted from and lowered back onto the Perspex table to allow it to relax fully. Removal of the residual funori started from the second facing layer by spraying it with water and then laying down blotting paper to absorb the water and funori from the surface; this operation was repeated twice. Funori residue was removed from the surface of the painting through the first facing in the same way but using Kimtech Science Delicate Task Wipes. In preparation for the first lining, the painting was placed face down on a carrier support of several layers of rayon paper and excess water was allowed to evaporate.

Paintings on silk generally need a rather strong support to stabilize them and to allow the scroll to hang flat. Relatively thick 3.4 momme (22 g.m⁻²) usumino paper, which is made from pure kozo fibre (630 × 925 mm), was chosen for the first lining to give the silk painting stability and aligned with the fibre direction parallel to the length of the painting, Figure 6. The paper was prepared for the first lining by dyeing and cutting as described in the technical appendix.

Each sheet of paper was sprayed lightly with water and brushed onto the lacquered surface of a wooden bench. Paste was then applied to the paper until it became evenly transparent and the bench underneath visible (details of the paste application can be found in the technical appendix). The pasted lining paper was hung on a wooden bar to lift it from the bench and was placed gently onto the painting while brushing it down, Figure 7. Further firm brushing through a sheet of humidified rayon paper ensured that all bubbles were removed and that the lining was completely attached to the painting. This procedure was repeated twice to line the whole painting and the joins (around 2 mm wide) were deliberately positioned around areas that were more heavily pigmented (to hide the slightly visible overlap) and relatively free of repairs or creases (to ensure stability). The safe execution of this crucial lining stage requires great expertise and long practice since the silk substrate does not have any substantial support at the time of lining.

After this first lining had been applied the painting was turned over and laid face up on the bench. The temporary carrier and first layer of facing were removed and any residual funori and wheat starch paste that had exuded through the painting’s weave were also removed by spraying the painting with water and absorbing it with Kimtech Science Delicate Task Wipes. The painting was supported on a sheet of rayon paper that was adhered temporarily to the first lining paper and left to dry slightly. It was then pressed overnight between layers of polyester sheet, blotting paper, felt and wooden boards with weights on top.
Application of paper reinforcement strips

It is crucial, as far as possible, to avoid creases in scrolls. Most old scrolls have many creases and even after replacing an entire lining, the painting substrate and paint media may still suffer from tears or the marks left by earlier creases, which have the potential to crack when the scroll is rolled after remounting. To avoid this, narrow strips of reinforcement paper (oribuse) are applied with very thin wheat starch paste to any areas where there is the risk of a crease. For this purpose 18 g.m$^{-2}$ kozo paper was cut into 1.5–2.5 mm wide strips with the fibre direction perpendicular to the length of the strips so that the fibres bridged the crease or tear, Figure 8.

This treatment was carried out under two different lighting conditions. First, the painting was placed on a Perspex table to allow transmitted light to be used. The paper reinforcement strips were applied to all the tears and any gaps between the silk substrate and silk repairs. Second, the painting was relaxed by spraying it with water, dried and then rolled around a tube of a similar diameter to the roller clamp that was to be attached later. Using raking light in a dark environment, creases were marked so that paper reinforcement strips could be applied once the painting was flat again. Several different angles of raking light were also used to look for creases while the painting lay flat. The hundreds of strips that were applied in this stage were further secured to the back of the painting with a third subsidiary lining.

Inpainting

Although all the repair silks had been dyed with natural alder cone dye prior to silk repair, further toning was required. Immediately before inpainting, the repair silk infills were sized at least twice with a 1% animal glue solution mixed with 0.1% alum in order to prevent the inpainting materials from being absorbed into the silk fibres. Guidelines for inpainting were agreed upon after extensive discussion between the curator, British Museum conservators and visiting Japanese conservators [4]. Inpainting was carried out after the final backing when the painting was assembled with its silk mount and stretched on a karibari drying board. One base colour was selected from the lightest areas of the background for toning all the repair silks; this base colour was then further adjusted to integrate with each surrounding area, Figure 9.

The repair silks under which reverse painting was visible were toned with a lighter colour than other repairs so as not to mask the original pigments on the verso, the colour being applied to the silk threads little by little, Figure 10. Three main colours were mixed to create the colour for inpainting: gamboge (yellow), synthetic indigo (blue) and synthetic carmine (red). Since gamboge is supplied as a resin while the red and blue come in the form of stick paints (bo-enogu) that already contain animal glue and beeswax, no further binder was added.

Because it was considered that completely brown silk patches in the blue sky would disturb the aesthetics of the painting, a small amount of azurite was added to the base
brown colour used on the repair silk in the sky area. This gave a slight blue tone that helped to blend in the repair and create a texture more harmonious with the original area, Figure 11. It should be noted, however, that this is not the standard approach that Japanese conservators would take on a National Treasure.

Storage

Before treatment, the hanging scroll was rolled onto a wooden rod with a 27 mm diameter. To increase this rolled diameter and thus minimize future creases, a detachable wooden roller clamp with a 67 mm diameter was installed after treatment. When in storage the painting is now rolled around this roller clamp, which is removed when the painting is on display. The painting is further wrapped in a double layer of degummed plain weave silk (habutae) and is kept in a box made from paulownia wood. The box was made specifically to accommodate the dimensions of the new mount. When the painting is inside the box, the metal roller knobs are held on wooden supports at both ends so that no pressure is exerted on the rolled scroll itself. The natural wooden box also acts as an extremely effective buffer to the external environment, responding to changes of humidity and ensuring the internal environment remains as stable as possible.

Mounting

Disassembly

Before the capillary washing, the painting was detached from its mount by cutting in the centre of the mounting strips, which joined the painting to the inner border mount silk fabric. Strips of paper 50 mm wide were adhered to the edges of the painting to ensure its safe handling and for stretching on a karibari drying board. The old wooden roller rod was removed from the bottom of the mount in the hope of revealing historical inscriptions, but none were found.

Subsidiary linings

Following the application of the first lining, the painting needed further lining to make it stable enough to be assembled with mount silks. The number of subsidiary linings needed varies depending on the painting and mount format. All three subsidiary linings applied on Death of the Buddha were misu paper (260 × 635 mm) made of kozo fibre containing calcium carbonate (in the form of oyster shell: gofun), which were adhered with aged paste (furunori). They were all aligned with the paper fibre direction parallel to the length of the mount. The thickness of the misu paper for each lining was chosen carefully from a stock that ranged between 11.0 and 25.0 g.m⁻², Table 5. After comparing the effect with different coloured linings, the misu paper for the second lining was dyed with alder cone extract in order to darken the appearance of the painting slightly. The pre-prepared rolls of misu paper were cut into lengths the width of the painting and the long sides were given a feathered edge.

The painting was humidified by spraying and brushing, and the prepared lining papers were placed onto a cypress wood board so that thin aged paste could be applied sparingly and uniformly with a brush, see the technical appendix for more information. The pasted paper was then applied to the verso of the lined painting. Because of the carefully measured amount of relatively weak adhesive applied, this lining was in contact with the painting but could still be lifted to adjust its exact position. The paper was brushed down firmly and pounded across the entire surface three times with a pounding brush (uchibake). From the second row of paper
applied onwards, the overlapping joins had to be made in such a manner that the feathered edges of the paper intersected exactly. Altogether, six and a half rows of misu paper were applied for each lining. The subsidiary linings were positioned such that the joins were staggered.

After the second and fourth subsidiary lining treatments, the painting was dried on a karibari drying board so that it was stretched and flattened for paper reinforcement strip application and mount assembly respectively.

**Mount fabric preparation**

After discussions between the curator and conservators, it was agreed to make a mount with new silk fabrics and that this mount should have larger proportions than the mount that was present before treatment [4].

Two gold brocade silks were selected for the new mount. White peony-patterned silk was chosen for the inner border and orange peony-patterned silk for the outer border. Plain purple silk was selected for the narrow mounting strips that join the painting and mount silks, Table 1. The proportions of the new mount and the positioning of the pattern on each of the silks were considered carefully.

To prepare the fabrics for lining, hanging gold threads on the verso of the outer border silk were cut off to ensure that the lining would make uniform contact with all of the silk; the fabric was also wetted and dried so that it shrank as much as possible before lining. The inner border silk was deemed to be too bright so alder cone dye was applied to give it a slightly browner tone and to make the gold threads less glossy.

Before they are assembled with the painting, mount fabrics must be lined individually so that each has a similar thickness and flexibility. For Death of the Buddha, both silk fabrics were lined with 2.3 momme (15.7 g.m\(^{-2}\)) usumino paper adhered with thick wheat starch paste. The pasted lining papers were left for about five minutes to allow excess moisture to evaporate before they were laid onto the verso of the dry silk fabrics. Since the patterns of the fabrics had been carefully aligned and set beforehand, great care was taken to ensure the pattern remained in position despite the silk undulating on contact with the pasted lining paper. At first the lining papers were brushed gradually to secure their position; once adhered satisfactorily they were brushed firmly and pounded gently with a pounding brush (a process only carried out for gold brocades). Second and third linings were later applied to the silk fabrics in the same manner as subsidiary linings to the painting. After the third lining the silks were dried completely on a layer of felt. The silks were humidified by spraying and brushing with water and then attached to karibari drying boards.

**Assembly**

The painting was detached from the karibari drying board and repair silk that had been applied to form a margin around the painting was cut to form a rectangle that left a minimum of 0.6 mm and an average of 1.5 mm between the original silk and the new edge. This margin has two purposes: to protect the original silk and to indicate that the painting has not been trimmed.

The silk mount fabrics were cut with a sharpened round knife (marubocho) and thick wheat starch paste was applied to the cut edges to prevent fraying. Narrow mounting strips were applied to the painting. A strip of very thick wheat starch paste with a width of 3 mm was applied with a brush to the edge of the verso of the painting and any excess paste was removed with a finger. The narrow mounting strip was then positioned using a straight edge as a guide. Once adhered, the strip was rubbed down by hand through a piece of paper and hammered three times with a small hammer. Paste was applied to the verso of the mounting silk as it had been to the painting, and the mount silk was then turned and placed onto the narrow mounting strip, again using a straight edge as a guide. As described above, a 3 mm pasted overlap left a 2 mm narrow strip visible between the component pieces,

| Table 5. Details of the lining papers used for the new mount |
|---------------------|--------------|--------------|--------------|--------------|----------|---------|
| **First lining** | **Second lining** | **Third lining** | **Fourth lining** | **Nakaura** | **Final backing** | **Thickness after mounting** |
| Painting | Mino | Misu | Mino | Mino | Misu | Uda | 0.51 mm |
| Thickness | 0.30 mm | 2.3 momme | Medium | Thin | Medium | Thick | 0.48 mm |
| Thickness | 0.26–0.30 mm | 2.3 momme | Medium | Thin | Medium | Thick | 0.48 mm |

Note

The ▼ symbol indicates that the paper fibre direction of the lining paper is parallel to the length of the painting and mount and the ↔ symbol that the paper fibre direction of the lining paper is perpendicular to the length of the painting and mount.
Table 1. The exact order of the assembly process is shown in Figure 12.

After all the silk parts were joined together, the long edges of the mount were scored, folded and trimmed to 5 mm wide. The mount was rolled face in and the edges were moistened with saliva by licking. The mount was kept in this rolled position overnight to help maintain the scored edges and the folded margins were stuck down with aged paste the next day.

**Backing**

After application of the overall subsidiary lining, thick wheat starch paste was applied to both folded edges of the mount silk. After it had dried, temporary margin papers were adhered to the mount’s edges by applying wheat starch paste to the margin’s feathered edge.

The final backing was composed of two sections. The upper part of the mount was covered with a layer of protective silk (outer reinforcement silk), which was applied with relatively thick aged paste. This silk acts as a protective cover when the scroll is rolled. The rest of the mount was covered by six rows of sympathetically dyed *uda* paper (320 × 1445 mm) applied with thin aged paste. *Uda* paper is made from *kozo* fibre with added kaolin (white clay: *hakudo*). Both silk and paper were firmly pounded with a pounding brush and the mounted painting was left to dry on a layer of felt.

After remounting, the painting had been lined a total of six times and the mount fabrics a total of five times.
Figure 13. Traces of underdrawing in the red-bodied guardian figure: visible image (top); and IR reflectogram in the 800–1700 nm range (bottom). The red boxes indicate possible areas of underdrawing and blue boxes highlight the shifted reverse painting.

Final drying of the mounted painting

Once the final lining has been applied to a mounted painting it must be dried under tension on a drying board to flatten and balance the mount. While resting on a sheet of rayon paper on a lacquered wooden bench, the mounted painting was humidified by spraying and brushing with water from the verso. When the painting was fully relaxed, it was moved to the karibari drying board to dry face out. Wheat starch paste was applied to the drying board to adhere the margin papers and, to ensure even drying, air was blown inside before sealing the edges. The straightness and width of the mount were carefully controlled and adjusted using straight edges. After two weeks, the mounted painting was released from the board and then reattached to avoid the risk of tears or delamination of the mount.

After inpainting had been completed, the painting was removed from the board once again to release any distortion and the verso of the mount firmly rubbed with glass beads to make it flexible. The painting was then reattached to the drying board face in. Experience suggests that the longer a mount is dried the more stable it will be as a hanging scroll. It is recommended that paintings should be dried for at least a few months. Because of the project schedule, it was possible to allow Death of the Buddha to dry for an entire year.

Finishing

Prior to finishing, the following preparations were made. The two decorative silk strips that hang from the hanging stave (futan) were made by sewing pieces of lined inner border silk to a light brown plain silk that had been lined with paper. A braid used for hanging and tying the scroll (takuboku, literally, a woodpecker) of 40 momme (about 8 mm wide) was selected and dyed with alder cone dye to match the tone of the mount. The roller rod and hanging stave were newly made from cedar wood. All the metal fittings used during finishing were newly made: metal roller knobs (kanajiku), decorative washers (kan), ring nails (kan) and decorative gilded copper carvings (hashibami) bearing a lotus design. The metal roller knobs were attached to both ends of the roller rod before it was sent to a joiner to make a roller clamp and storage box to the scroll’s exact size.

The mount was released from the drying board and the paper margins were folded back and trimmed to reveal 1 mm of the mount silk on the verso. The roller rod, wrapped in a paper pocket inserted during the final backing, was attached to the bottom of the mount. After the mount was rolled around the roller clamp, it was placed face down on a bench and the hanging stave was attached. The two decorative silk strips were sewn to the top of the mount. Four sets of decorative washers and ring nails were attached to the hanging stave and the decorative gilded copper carvings were capped onto its edges, Figure 12. Finally the hanging cord was tied to the hanging fittings and the wrapping cord attached to the hanging cord.

Scientific analysis

Technical imaging

A number of imaging methods were employed to examine the painting, using visible, infrared and ultraviolet radiation (see Verri [5] for full details).

Infrared reflectography (IRR) is most frequently used in museum contexts to reveal hidden features or preliminary drawings beneath painted surfaces [6]. Carbon is extremely opaque to IR radiation and this technique is therefore particularly useful where such sketches are likely to have been made in a carbon-based medium, as would be expected for a painting of this type. IRR of the painting revealed the existence of some thin lines of a material opaque to IR, probably carbon, under the paint layers of the body of the Buddha and a red-bodied guardian figure, Figure 13. These may correspond to the presence of a preliminary drawing, but could equally be part of the ink-based line drawing used for the outlines of the figures, which is now obscured by the application of paint. A few much less distinct lines under the surface of the painting are also visible in the reflectograms. These were found to correspond to the shifted pigments on the lining paper.

The IRR image also showed a broad dark band at the top of the painting, presumably applied to create a suitable background for a dark blue sky at nightfall. The band was executed in a material that is highly opaque to IR radiation and which pigment analysis later showed to be carbon based (see below).

Ultraviolet-induced luminescence (UIL) imaging was also carried out in the hope of revealing organic pigments or luminescent conservation materials on the painting. The only observable luminescence (a strong yellow/white) came from the white pigment, which was later found to be a basic lead chloride.

Pigment analysis

The pigments present on the painting were analysed using the complementary techniques of XRF and Raman spectroscopy,
The study and conservation of the silk painting *Death of the Buddha* with XRF providing information on the elements present and Raman giving compound-specific identifications. As both methods are non-destructive, non-invasive and do not require contact with the painted surface, they are particularly suited to this type of analysis. For practical reasons, given the fragility and size of the painting, the analysis in this case was undertaken on pigment offset onto sections of the backing papers rather than on the painting itself (Figure 14), with the backings then being refitted onto the painting as described above. The results are given in Table 6.

**Table 6. Analytical results for the pigments offset onto the backing papers of *Death of the Buddha***

<table>
<thead>
<tr>
<th>Colour</th>
<th>XRF results</th>
<th>Raman results</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lining paper with no pigment</td>
<td>S, Ca+, Fe, Mn(tr), Ti(tr), Cu, Pb, Sr</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>Green</td>
<td>Not measured</td>
<td>Malachite, Cu$_2$CO$_3$(OH)$_2$</td>
<td>Malachite</td>
</tr>
<tr>
<td>Blue</td>
<td>Si(tr), Fe, Pb, Cu++</td>
<td>Azurite Cu$_3$(CO$_3$)$_2$(OH)$_2$</td>
<td>Azurite</td>
</tr>
<tr>
<td>Dark blue</td>
<td>Si(tr), Fe, Pb, Cu++</td>
<td>Azurite, Cu$_3$(CO$_3$)$_2$(OH)$_2$ and carbon</td>
<td>Azurite and carbon</td>
</tr>
<tr>
<td>Yellow</td>
<td>Not measured</td>
<td>Goethite, FeO(OH)</td>
<td>Yellow ochre containing goethite</td>
</tr>
<tr>
<td>Gold</td>
<td>Si(tr), S, Fe, Cu, Au, Hg+</td>
<td>Not measured</td>
<td>Gold over cinnabar/vermilion</td>
</tr>
<tr>
<td>Red</td>
<td>Not measured</td>
<td>Cinnabar/vermilion, HgS</td>
<td>Cinnabar/vermilion</td>
</tr>
<tr>
<td>Gold over red</td>
<td>Si(tr), S, Fe, Cu, Au, Hg++</td>
<td>Not measured</td>
<td>Gold over cinnabar/vermilion</td>
</tr>
<tr>
<td>Dark red</td>
<td>Not measured</td>
<td>Cinnabar/vermilion, HgS</td>
<td>Cinnabar/vermilion</td>
</tr>
<tr>
<td>Orange</td>
<td>Not measured</td>
<td>Red lead, PbO$_4$</td>
<td>Red lead</td>
</tr>
<tr>
<td>Pale flesh</td>
<td>Not measured</td>
<td>Orange – cinnabar/vermilion, HgS and red lead, PbO$_4$</td>
<td>Mixture of cinnabar/vermilion, red lead, yellow ochre and lead chloride</td>
</tr>
<tr>
<td>Dark flesh</td>
<td>Not measured</td>
<td>Red – cinnabar/vermilion, HgS</td>
<td>Mixture of cinnabar/vermilion and yellow ochre</td>
</tr>
<tr>
<td>Salmon pink</td>
<td>Not measured</td>
<td>Red – cinnabar/vermilion, HgS</td>
<td>Mixture of cinnabar/vermilion and red lead</td>
</tr>
<tr>
<td>Dark brown</td>
<td>Not measured</td>
<td>Black – carbon</td>
<td>Mixture of carbon-based black and yellow ochre</td>
</tr>
<tr>
<td>Black</td>
<td>Not measured</td>
<td>Yellow – goethite, FeO(OH)</td>
<td>Carbon-based black</td>
</tr>
<tr>
<td>White</td>
<td>Al, Si, K(tr), Fe(tr), Cu, Pb++</td>
<td>Paralaurionite, PbCl(OH)</td>
<td>Lead chloride</td>
</tr>
</tbody>
</table>

Notes

a. For the coloured areas only those elements present in higher quantities than found in the lining paper are listed. The symbols + and ++ indicate the presence of higher concentrations of a particular element and (tr) indicates that the element is present in trace quantities.

b. Several colours were produced by mixing a number of pigments. These were identified and are listed individually.
The pigments found are typical of Japanese painting of this period with the reds being provided by red lead and cinnabar/vermilion. With the methods of examination available it was not possible to distinguish between the use of the natural mineral cinnabar or its synthetic analogue, vermilion. The greens and blues are the copper carbonates, malachite and azurite, while the yellows contain the iron oxide goethite, most probably representing the use of a natural earth [7]. No evidence was found for the use of the arsenic sulphides, orpiment and realgar, or of gamboge. As is typical of East Asian painting, an amorphous carbon was used for the black.

On historical grounds this is most likely to be derived from soot but it was not possible to confirm this. The white pigment used, basic lead chloride, which is present here in the paralaurionite crystal form, is considerably more unusual within ancient palettes but seems to have been in common use in Japan at the time this painting was produced, having been found by Winter on the majority of a group of 29 twelfth- to fifteenth-century Japanese paintings [7, 8]. It appears to have been superseded as a white in Japanese art by calcium-based pigments from the sixteenth century onwards but its use here would certainly fit well with the known date of this painting.

Conclusions
This article, by providing just a glimpse of the complicated and precise procedures involved in the full conservation and remounting of a Japanese painting, hopes to have shown that in order to make appropriate decisions about conservation treatment procedures it is essential to gather historical information about the painting and mount and fully to understand their structures, especially in the case of a painting as complex as Death of the Buddha.

As shown, Japanese painting conservation cannot easily be divided into conservation and mounting treatments. In the last half century, the influences of scientific advances and Western conservation theory have improved Japanese conservation treatments. Using this painting as an example, treatment has been greatly facilitated both by high quality imaging and pigment analysis, and by the availability of new materials such as synthetic papers and artificially aged repair silks. Yet it must be borne in mind that the conservation techniques used are still based on the long history of traditional mounting, and that when investigating or treating a painting there is no substitute for a scroll mounter’s experience.

The mounting aspect of this treatment has been recorded in great detail, from the width of a feathered edge to the consistency of a funori solution, but what must be appreciated is that these are subtle details that an experienced mounter would achieve almost unconsciously. Although conservation techniques continue to improve, traditional mounting techniques have been perfected over hundreds of years. Mounters today must, therefore, focus on improving individual skills so that they can attempt to emulate past master mounters who, through their more intensive training and work life, acquired greater practical experience. To compensate for the inevitable gap in practical skills, modern mounters analyse their techniques thoroughly and keep comprehensive measurements and records of each treatment in an attempt to understand, and perfect, their craft more fully.

Supported by curators and scientists, contemporary conservators can learn much through careful investigation of the mounts applied to preserve paintings by previous generations of scroll mounters. Hopefully, when the time comes for a future generation of mounters to remount Death of the Buddha, they will be inspired and impressed by its recent treatment and current mount.

Experimental appendix
Technical imaging
All the images, except the IR reflectograms, were taken using a Canon 40D camera body modified by removal of the inbuilt UV-IR blocking filter, allowing use of the full spectral range of the CMOS sensor (c.300–1000 nm), and a Canon EF 50mm f/1.8II lens. The wavelengths used were selected by placing a filter or a set of filters in front of the lens. Illumination for visible and infrared imaging was provided by two Classic Elinchron 500 Xenon photographic flashlamps equipped with a diffuser that were positioned symmetrically at approximately 45° with respect to the focal axis of the camera [9, 10].

-UIL imaging: Excitation was provided by two Wood’s lamps (365 nm) filtered with Schott DUG11 bandpass interference filters (280–400 nm) and the camera was fitted with a Schott KV18 cut-on filter (50% transmission at c.418 nm) and an IDAS-UlBAR bandpass filter (400–700 nm).

-IRR: Infrared reflectograms were captured using an Osiris Imaging System camera with an InGaAs array (sensitivity c.800–1700 nm), a six-element 150 mm focal length f/5.6–f/45 lens and a Schott RG830 glass filter positioned in front of the lens.

Pigment analysis
-XRF: XRF analysis was carried out using a Bruker Artax spectrometer, fitted with a molybdenum X-ray tube and operated at 50 kV and 500 μA. The analytical spot size was c.0.65 mm and spectra were collected for 300 s. Helium gas was introduced into the area between the object and detector in order to allow greater sensitivity in the detection of lighter elements. As the pigment deposits on the lining paper were very thin compared to the depth of penetration of the X-ray beam, each analysis reflects the elements present in both the pigment and paper. To allow for this, a spectrum was collected from a blank area of the lining paper and the result subtracted from those collected for pigmented areas to give results for the pigments. The paper was also supported in such a way that there was an air space beneath it, rather than resting it directly on a surface, as otherwise elements from the supporting surface might have been included in the analysis.

-Raman spectroscopy: Raman spectra were obtained using a Horiba J地坪 Yvon LabRam Infinity spectrometer with green (532 nm) and near infrared (785 nm) lasers with maximum powers of 1.2 and 8.3 mW at the sample respectively (although in this case lower powers were used), a liquid nitrogen cooled CCD detector and an Olympus microscope system. This allowed tiny areas containing one or two grains of material to be targeted for analysis, with a sample spot size in the order of a few microns in diameter.
depending on the power of the objective lens used. Spectra were collected for between 5 and 20 s, with at least five scans used to produce each spectrum. The resultant spectra were identified by comparison with a British Museum in-house database.

**Technical appendix**

The purpose of this technical appendix is to explain in greater detail some of the individual procedures undertaken in a scroll mounting treatment such as that performed on *Death of the Buddha*, including the preparation of some materials and their application.

**Paper joins**

There are three methods of joining sheets of paper for lining: straight edges (knife cut: **bōtsugi**), feathered edges (water cut: **kuisaki**) and one feathered edge joined over one straight edge (**katakuisaki**). Historically, straight edges were most often used for linings, since feathered edges are a relatively new trend in the long history of Japanese scroll mounting. Currently, only **bōtsugi** or **katakuisaki** are used for the first lining of a silk painting or silk fabrics while most other linings use **kuisaki**.

Feathered edges are made by tearing the edge of a sheet of paper. The paper is first scored using a bamboo spatula to make a channel about 2–3 mm wide to which water is applied using a very thin brush before the edge is pulled away using the wrist. The feathered edges can be settled by brushing with a dry brush. In some cases, long feathered edges are trimmed with a knife in order to avoid the edge carrying too much paste; this procedure was followed when applying the first lining paper in the treatment of *Death of the Buddha*.

It is common practice to join papers and then roll them up into a continuous roll before use as this is more efficient and economical. The previous lining papers used for *Death of the Buddha* seem to have been pre-joined with straight edges or feathered edges. The subsidiary linings applied during the recent treatment were normally joined beforehand in a similar manner. To avoid a sudden change in thickness in the roll, the sheets within a batch of paper are first sorted according to their thickness. The **misu** papers used here had both side edges trimmed with a feathered edge. The pile was then loosely folded in the centre to create a fan of paper edges (resembling steps), which allowed both side edges to have a narrow line of thin aged paste applied simultaneously. The sheets were then joined together and rolled until the roll reached the required length.

**Funori preparation**

Funori was prepared the day before the facing treatment in two different ways. First, all the **funori** to be used was rinsed under running water. A batch of **mizudashi funori** was prepared by stirring and soaking the **funori** in water overnight at room temperature before sieving it through a piece of fine cotton — it was not cooked at any stage. Additionally, a batch of **nidashi funori** was prepared by heating the **funori** in simmering water for approximately one hour before sieving. The **funori** extracted at room temperature has a lower molecular weight than the **funori** extracted using the conventional heating method and it is believed to be more likely to dissolve in water, suiting it well to the facing treatment [11, 12]. However, because it was known that the lining removal treatment would be especially complicated, **nidashi funori** was added to the **mizudashi funori** for the facing treatment to ensure secure adhesion. For the first three facing layers the ratio of **mizudashi to nidashi** was 3:1, while a ratio of 1:1 was used for the fourth and fifth layers.

**Facing**

The facing process was carried out in a number of stages, as illustrated in Table 4. The first facing layer was composed of 150 × 120 mm pieces of 12 g.m–2 rayon paper, which were applied to the painting by brushing **funori** directly through them with a small brush. The second layer also comprised 12 g.m–2 rayon paper, but was applied in one continuous sheet that covered the whole painting with the paper fibre direction perpendicular to that of the first layer. It was adhered to the first layer simply by brushing, soaking up the residual **funori** from the first application before further **funori** was added by brush. The third layer consisted of two pieces of 18 g.m–2 rayon paper with the fibre direction parallel to that of the first layer; the layer was adhered by adding further **funori** through the sheet with a brush. The fourth and fifth layers were pre-adhered to each other with **funori** on a lacquer bench before adhering them to the third layer; the fourth layer was a single piece of 12 g.m–2 rayon paper and the fifth layer was 20 g.m–2 **usunma**, both with the paper direction parallel to that of the second layer.

**First lining paper preparation**

Choosing the colour of the first lining for a silk painting is an extremely important and also very subtle stage in the treatment. If the paper is too light the painting will appear weak, while if it is too dark the detail of the painting will be diminished. In addition, if the colour of the lining is too similar the painting will appear flat and without texture. Three sheets of **usunma** paper were dyed with direct dye, first by immersion in a dyebath then by brushing with dye. The sheets were dried on a layer of felt, rinsed in running water and then dried again between each dyeing stage. After dyeing, the paper was steamed, dried and then sandwiched between damp blotting paper to ensure that the colour was fixed. The dyed **usunma** paper (630 × 925 mm) was trimmed and cut to the width of the painting (plus the width of a margin) with straight edges. Three such sheets were joined on the painting to form the lining.

**Paste application**

During lining treatments, the board used for paste application is chosen depending on the thickness of the paste to be used. When thin paste is used, for example fresh wheat starch paste for the first lining of a paper painting or aged paste for subsidiary linings, then the paste is always applied to the lining papers on a cypress wood board that helps to absorb excess moisture. However, when thick paste is used, for example for the first lining of a silk painting or mount fabric, then the paste is applied to the lining papers on a lacquered wooden surface that helps the lining papers settle during pasting.

For thin paste application, paste should be applied little by little, carefully controlling the amount applied. Applying too much paste at once can easily disturb the fibres of the lining paper. The pasted lining paper is then applied onto the object immediately.
For thick fresh paste application a considerable amount of paste is applied initially to the paper in a firm manner, as if being beaten into the fibres; the amount of excess paste is later reduced by changing the angle and pressure of the brush. To ensure sufficient adhesion, a lining paper pasted with thick paste is often dried slightly on a layer of felt before it is applied, allowing the excess moisture to evaporate.

**Reinforcement strip preparation and application**

A pile of 315 × 460 mm *kozo* paper sheets was folded in half and cut into strips. This group of strips was then opened up and placed onto a wet wooden board where thin wheat starch paste was applied. Each strip was next lifted and rolled around a bamboo spatula to enable long strips to be gently and precisely unrolled and laid down one by one according to the length of the crease. The strips were pressed and rubbed down using the face of a fingernail.

Reinforcement strips are applied after the second rather than the first lining to avoid the impression or colour of the strips being visible through the painting. Also, the strips adhere better to the *miwa* paper that is used for the second lining rather than the *asumino* paper used for the first lining.

**Wheat starch paste**

In the Hirayama Studio at the British Museum fresh wheat starch paste (*shin-nori*) is made every week using wheat starch powder. Wheat starch powder is mixed with filtered water (about 18% w/w) and stirred hard over heat for more than half an hour; the duration of cooking depends on the amount of paste to be made. The cooked and cooled paste is always sieved before use, diluted with filtered water and mixed with a brush to reach the appropriate thickness. According to information supplied by Nagata Sangyo Co. Ltd, the wheat starch paste powder consists of 99.3% starch, 0.4% protein and 0.3% ash. Wheat starch is also sold in moist lumps (*namajin*), which are often used instead of wheat starch powder in conservation and mounting studios in Japan.

**Aged paste**

Aged paste is wheat starch paste that has been covered with water in a large jar and stored in a cool basement for 10 years with the water replaced once a year. For the treatment of *Death of the Buddha* aged paste was sieved and diluted with filtered water. Because aged paste is a very weak adhesive its application is always followed by the use of a pounding brush to ensure firm bonding of the paper fibres. Although aged paste gives flexibility to the lined object, making it suitable for subsidiary linings and the final backing of rolled scrolls, it is never used for the first lining of a painting or other two-dimensional objects.

**Use of a karibari drying board**

It is generally preferable to dry a painting or silk fabric naturally on a layer of felt before attaching it to the *karibari* drying board as a firmer adhesive bond is formed. However, when a painting has a thick pigment layer, the differential shrinkage between the substrate and the painting medium can cause delamination if it is allowed to dry naturally without being under tension. Objects can also be placed on the *karibari* drying board immediately after lining if it is necessary for them to be stretched to the greatest extent possible. If a painting is unsuitable for natural drying but is also too weak to be stretched on a karibari drying board, it can be pressed dry completely (as was done after the first lining of *Death of the Buddha*) or pressed briefly before it is attached to a karibari drying board (as was done after the facing of *Death of the Buddha*).

The Japanese term *karibari* refers to both the drying board itself and to the process of temporarily stretching and attaching a lined piece of paper or silk to the face of a board by applying paste along all four edges. The board consists of a wooden lattice core covered in around 10 layers of paper applied in a specific manner that makes it similar in structure to a folding screen [13]. The outer layers of the karibari drying board are covered in persimmon juice (*kakishibu*) making it largely water resistant, but still with the capacity to expand and contract with changes in humidity. This flexibility is the great benefit of the karibari drying board compared to a rigid board. When a humidified lined object is applied to the board the board itself is slightly humidified and expands along with the object, just as it dries and shrinks as the object dries. This reduces the risk of damage, for example the formation of tears at weak points on the object or the delaminating of the object from the drying board due to excess tension.

**Paper fibre direction of lining papers**

Paper fibre direction greatly influences the flatness (*kakari*) of a mount [14]. As a hanging scroll (which is composed of many layers) is kept rolled it develops a tendency towards that rolled position. Therefore, when unrolled for hanging it is in a state of tension and it is natural for it to appear concave [15]. Generally, adhering a handmade *kozo* lining paper with the fibre direction running vertically – parallel to the length of the mount (indicated by the symbol ‡ in Tables 2 and 5) – provides strength but also makes the mount less flexible to roll. It also makes the hanging scroll slightly convex, which counters the scroll’s natural tendency to appear concave. If, however, the lining is applied with the fibre direction running horizontally – perpendicular to the length of the scroll (※) – the scroll has greater flexibility but tends to become even more concave.

For that reason, in a standard lining approach, most of the lining papers are applied with the fibre direction parallel to the rolling direction. For a hanging scroll the paper fibre direction is vertical (‡) whereas for a hand scroll, because it is opened and rolled laterally on a table, the paper fibre direction is horizontal (※). There are instances, for example the first lining of a paper substrate or some subsidiary linings, when the alternative fibre direction is chosen in order to balance the flexibility of a scroll or to reduce its tendency to curl. The paper fibre directions of all the linings of *Death of the Buddha* (both the new and old mounts) are outlined in Tables 2 and 5.

**Mount balance**

When mounting different materials together, balancing their various characteristics is essential. This applies not only to their thickness, but their flexibility (*koshi*) and expansion and contraction rates. If one material is stiffer than another it should be slightly thinner (for instance a painting is usually thinner than the mount silks surrounding it, yet has more stiffness). It is only possible to judge whether the separate parts
have been lined appropriately after the entire mounting treatment is complete; if not perfectly balanced, thinner parts of the mount will become convex. So the number of linings used are considered for each material at each lining stage.

The dimensions of *Death of the Buddha* (712 × 1357 mm before treatment) were taken at different stages of the treatment process. From its largest (immediately after lining and pounding) to its smallest point (completely dry), there was a difference of approximately 15 mm in both height and width. It must be borne in mind that each different mount silk component also expands and contracts to different degrees and at varying rates. So when the painting and mount fabrics were joined together, an estimate had to be made of the change in size of each different component after assembling and final backing. Each component silk was thus treated differently during mount assembly—some were pre-shrunk so that on being joined they would not shrink substantially more than others, while others were stretched as tightly as possible to accommodate the eventual shrinking of surrounding silks.

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**References**


**Notes**

1. For more information on the dimensions of Japanese paper see Kume [16].

2. The futomaki is also sometimes referred to as futomaki shio or futomaki sekkika.

3. Original silk details: warp 70 m (Japanese term relating to pairs of warp threads) equivalent to 117 EPI (ends per inch), c.14 denier; weft 120 yoko (Japanese term relating to weft threads) equivalent to 142–160 EPI, c.14–21 denier. Repair silk details – warp 60 m (100 EPI), c.14 denier; weft 120 yoko double (200 EPI), c.14 denier. The silk was aged using electron beam radiation at the Takasaki Advanced Radiation Research Institute, Japan Atomic Energy Agency.

4. Rayon paper is a non-woven fabric that consists of 75% rayon fibre, 15% wood pulp and 10% polyvinyl alcohol. Samui is also a non-woven fabric produced by Sanwa Shichi Co Ltd. This machine-made tissue is composed of 95% polyethylene, 3% polypropylene and 2% wood pulp. For more information see Morita [17].

5. Momme is the unit most widely used for the weight of paper in Japan but also commonly refers to its thickness. In weight terms, one momme equates to around 3.75 g. This measure is used to compare Japan but also commonly refers to its thickness. In weight terms, one momme equates to around 3.75 g. This measure is used to compare

The study and conservation of the silk painting *Death of the Buddha* | 57