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Investigations into textile treatment options for the cornices and corbels from Queen Caroline's State Bed, Hampton Court Palace

Abstract

This paper examines the decision-making process for the conservation of the cornices and corbels from Queen Caroline's State Bed c.1715, which is on open display at Hampton Court Palace. The three cornices and two corbels are composite objects, made of carved wood, with adhered crimson silk damask and silk braid. The ethical principles guiding the treatment decisions reflect the previous conservation, institutional aims and context within the palace.

Practical stain removal tests with mock-ups used Agarose gel to target soiling and minimise moisture absorption into the wood. Gel additives of chelating agent tri-ammonium citrate and protease enzyme from Aspergillus oryzae were successful in targeting different types of soiling.

Other investigations involved assessing the reversibility of 1980s infill patches adhered with Beva® 371 film which was achieved using Agarose gel with propan-2-ol. These substantial areas of plain patches were considered too disruptive to the continuity of the damask pattern so alternative infills were trialled, finally settling on painted dyes.

The results of these tests have determined our decisions prior to the start of the full treatment as well as informing the conservation of other elements of the bed.

Keywords

State bed, upholstery, animal glue, pH, gel cleaning, textile, wood, adhesives

Fig. 1 Queen Caroline's State Bed before conservation on display at Hampton Court Palace.

Introduction

Historic Royal Palaces care for six State beds in the collection of The Royal Collections Trust. Queen Caroline's Bed (fig. 1) is the final bed in our care to require a full conservation treatment. Despite its seemingly solid presence, Caroline's structure was fragile and had not been fully dismantled since 1981. The cornices have not been removed from the bed since their reinstatement in the late 1980s so this is our first opportunity to fully conserve these objects in 35 years. The conservation project began in 2017 with the finials, inner valances and mattresses before the main de-installation took place in October 2018. We worked with Tankerdale Ltd. to take down the bed, label and pack the components and we have now begun to work our way through the individual elements (fig. 2 and fig. 3). This paper will focus on one set of objects in this large conservation project; the three cornices and two corbels, which form the decorative line around the top of the bed.

Fig. 2 Tankerdale Ltd. preparing to take down a corbel.

Fig. 3 Conservators packing the individual elements.

Historical background

The bed was made in 1715 for George, Prince of Wales (later George II) and his wife Caroline of Ansbach for their occupation of Hampton Court Palace, where it has remained ever since. The bed is entirely covered in crimson silk damask of a large compartmented foliate design known as Hampton Court Palace. The design is embellished with various widths of silk Arras lace braid.[1]

1. V. Davies, State Beds & Throne Canopies Care & Conservation, Archetype, 2003, 24-25.

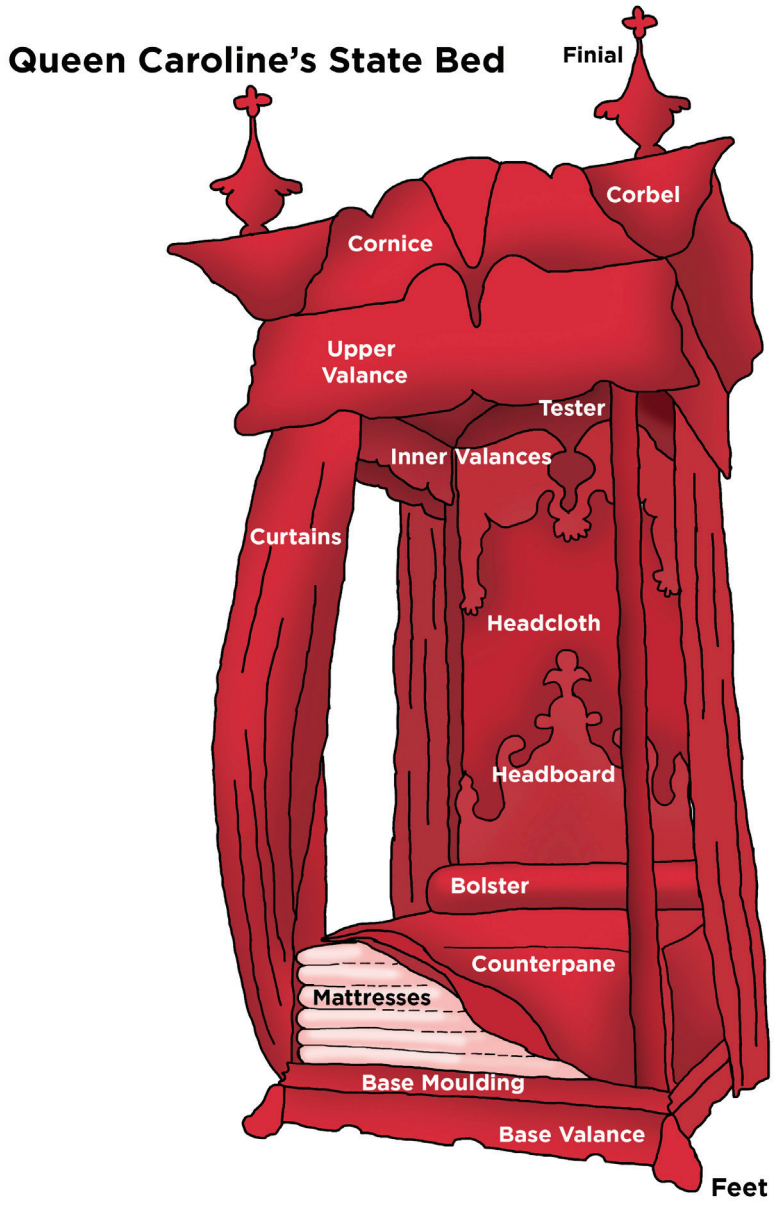

Fig. 4 The bed's components.

The bed is one of our tallest standing at 488cm high. It has oak bedposts which support a heavy carved full tester of pine, with three carved cornices, two carved corbels, two valance arms and four finials. A rare survival are the two purely decorative feet (fig. 4). There are 41 separate textile elements in total and many are composite, being textile adhered to wood with animal glue.

A warrant of 1715 shows the makers involved and materials ordered. What is notable is the relative good value for money of the bedstock at £42. The silk damask, braid and taffeta (for linings) were far more costly at over £1000.[2] This equates to over £100,000 today,[3] making it a considerable investment. As conservators, we feel the need to reflect the superiority of the materials we care for both in the quality of conservation additions as well as the standard of finish we aim for.

2. Davis, 2003, 25.

3. The National Archives, http://www.nationalarchives.gov.uk/currency-converter (accessed 4/5/2019).

Fig. 5 Examining the upper composite objects prior to de-installation.

Treatment aims

Our conservation work aims to last for at least 50 years on open display. We seek to improve the condition, mitigate future instability and the need to re-treat. We must also lower the State of the Interior Estate (SOIE) condition rating, which is an in-house grading system used to evaluate the need for, and success of treatments. We need a consistent approach to our interventions and to achieve a coherent look to the bed. To ensure authenticity we work from a conservation, rather than restoration perspective, preserving as much of the original as possible.

The bed attests to the generations of previous treatments varying from historic restoration to conservation. The most recent documented treatment of the bed began in 1981 until a large fire at Hampton Court in March 1986 disrupted work. A report from 1984 as well as further additional work carried out in July/August 1986[4], relates to the Foot cornice alone but must also provide an indication for the other cornices and corbels. These treatment records were crucial in guiding our proposals.

4. Hampton Court Palace Conservation Archive, Technical Record Card, Unpublished, 1984 and 1986.

The quality of the original materials and setting within the palace does have an impact on our treatment aims. We seek to alter the original as little as necessary, especially where there is original stitching or adhesive. We would not remove original damask, which has been carried out previously, and repairs that have been poorly executed or are no longer functioning are approached less cautiously. The most important aspect of our treatment is the continuation of the original part of the object, because it is deemed that the bed's original function of use by a particular monarch is of a higher significance. We must also consider the impressive spectacle the bed would have been intended as and seek to recreate that atmosphere for our visitors.

Composite construction

Each cornice and corbel is constructed from elaborately carved pine covered with crimson silk damask and silk braid. The wooden parts are adhered or nailed together, and the cornices are attached to the tester on spikes protruding from the top of the bedposts. Some additions have been made to this original construction. There are screw fastenings and holes indicating that the cornices have been joined together and additional wires fixed at the back. The wooden structure of the objects has been assessed and treated by an external furniture conservator. There were several cracks and evidence of movement to the structure, as well as some previous repairs requiring re-treatment.

Staining and stain removal tests

Stain removal aims

The soiling found on the cornices can be categorised into three types. Firstly, the yellowing of the damask, particularly severe on the foot cornice which receives the most light due to the positioning of the bed in the room (fig. 6). Secondly, water staining, probably from rusty pipes that had leaked through the ceiling above, disfigured some areas (fig. 7). We also found some areas of darkened repair adhesive, which Dino-Lite magnification showed to be animal glue (fig. 8).

Fig. 6 Discolouration from degradation.

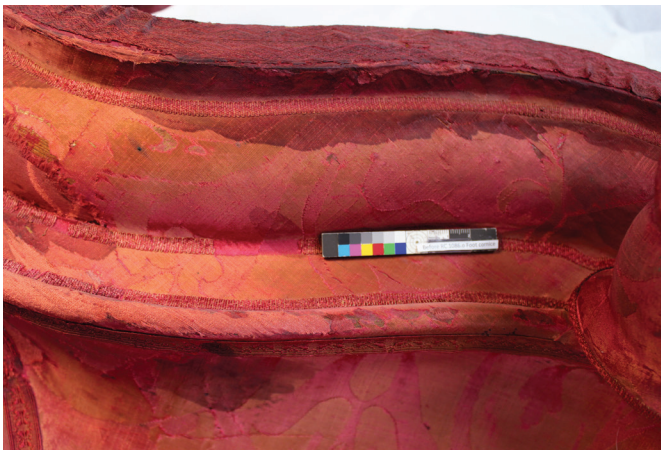

Fig. 7 Water staining.

Fig. 8 Darkened repair adhesive.

The 1984 report describes an unsuccessful blotter wash,[5] which lacked the control needed to prevent wicking. Although the desire to reduce these types of soiling was apparent, it is only our recent familiarity with gels, which introduce moisture in a controlled manner, that further treatment options can be trialled. We aim to benefit the condition by removing harmful soiling but also to achieve aesthetic improvements, such as by reducing the yellowing of the foot cornice to a similar level as the other cornices.

5. Hampton Court Palace Conservation Archive, 1984 and 1986.

The finials were the first objects to be treated in 2017 and so research undertaken for these objects helped to inform the proposals for the similarly composite cornices. The conservators found the surface cleaning methods using chemical sponges and groom stick removed much soiling from the interstices of the weave, so we will also be carrying out this treatment on the cornices. During the finial treatment the conservators tested alternatives xanthan gum and silicone-based gels as well as concentrations of each (fig. 9). They found 4% or 6% w/v Agarose gel in de-ionised water to be most effective,[6] so we primarily used this research to guide our decisions. Our tests will therefore involve agarose gel to clean in a more controlled manner than the previous blotter wash.

6. C. Gamper and R. Chamberlin, Finial Working Notes, Unpublished, 2017.

Fig. 9 The finials during treatment.

Test parameters

Our new tests for the cornices sought to reduce the three types of soiling not previously attempted: degradation yellowing using plain agarose, water stains using chelating agent in agarose and aged animal glue using enzymes in the gel. Agarose gel was particularly appropriate because it retains its structure without leaving any residue, is pH neutral and is the most versatile gel being compatible with additives such as chelating agents and enzymes,[7] both of which we used in our tests. With these composite objects we needed to avoid swelling the wood or drawing up further acids from the wood itself into the textile, so the gel provided a controlled way of introducing moisture.

7. M. Sullivan, S. Brogdon-Grantham, and K. Taira, 'New Approaches to Cleaning Works of Art on Paper and Photographs', in ANAGPIC, 2014.

In order to ascertain effectiveness, practice and refine our techniques mock-ups were made before we tested on the objects themselves. We adhered new (replica) silk damask to blocks of pine with animal glue (fig. 10). The type of original glue was assumed to be 'Pearl' or animal glue.

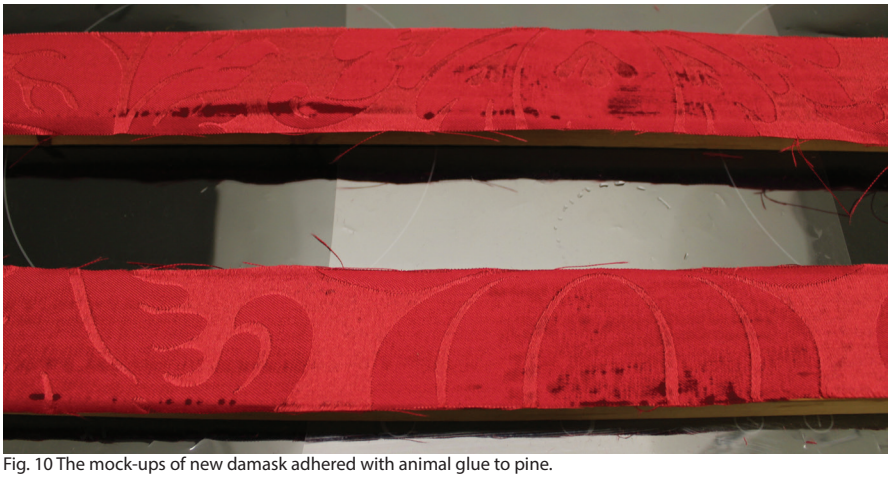

Fig. 10 The mock-ups of new damask adhered with animal glue to pine.

Our tests were carried out in our washbuilding, where the treatment will take place, which has quite variable temperature and Relative Humidity (RH) conditions. An RH of 65-95% causes animal glue to swell and shrink but this depends on how the original was made and the type of binding media used, such as chalk. Aged adhesive will respond less to changes in temperature and RH than new. The precise effects cannot be predicted, but it could cause cracking of the adhesive.[8] Animal glue becomes liquid from 50-63°C, and above this temperature the collagen may begin to lose strength,[9] so our tests were restricted by this.

These variables in the original production process and level of degradation were not attempted to be replicated. The tests used un-aged animal glue without a binding media and new textiles. We did identify further shortcomings of using these test pieces in that our soiling could not reproduce the intensity of the real water stains. Therefore, the mock-up tests were used to identify potential problems, ascertain effectiveness and refine treatment times before testing was carried out on the objects themselves.

8. Á. Tímár-Balázsy and D. Eastop, Chemical Principles of Textile Conservation, Butterworth-Heinemann, 1998, 119-121.

9. N. C. Schellmann, 'Animal glues: a review of their key properties relevant to conservation', in Studies in Conservation, 52 (Supplement 1), 2007, 56.

Degradation yellowing tests

Because the acidic products of silk degradation that appear as yellowing are water soluble,[10] we used the agarose gel as a controlled way of introducing moisture. The agarose powder was added to de-ionised water and heated to 90°C with a magnetic stirrer, poured into a petri dish and allowed to cool. All gels were made to a thickness of 2mm to assist with contact to the object.

A small gel plug was cut and applied to the damask in a discreet area on the object (fig. 11). The 4% w/v gel was applied for 10 minutes and had visible efficacy in drawing the yellow soiling into the gel. We made a visual assessment of whether the moisture was penetrating the wood by testing on the edge of the object where we could see a cross-section, which proved satisfactory. There was some improvement in the appearance of the test areas and tide lines were not created. There was limited disruption to the powdering silk fibres and swelling of the wood was avoided suggesting the full treatment would be effective.

10. Tímár-Balázsy & Eastop, 1998, 46.

Water staining tests

We firstly tested a de-ionised water Agarose gel which had limited efficacy on the staining. Previous experience of treating similar dark water stains suggested a chelating agent would be required, which would bond with the metal ions from the leaky pipes. We tested two different chelating agent gels: 0.5% w/v EDTA (Ethylenediaminetetraacetic acid) and 1% w/v Tri-ammonium citrate (Ammonium 2-hydroxypropane-1,2,3-tricarboxylate).[11, 12] Both were added to 6% agarose gels prior to heating.

We found tri-ammonium citrate to be more effective in our relatively short 5 minute treatment time (to avoid excess moisture), which was also favourable due to its neutral pH (fig. 12). We saw good results in reducing the staining, with yellow soiling also visible in the gel (fig. 13). Because rinsing was not possible, we relied on the same rate of capillary action by using a plain gel for the same amount of time (5 minutes) to draw up the chelating agent.

11. V. Chapman, 'The Conservation of a Painted Silk Tambourine – and Tri-ammonium Citrate', in Painted Textiles; UKIC Textile Section Forum Postprints, Edited by V. Lockhead, 1997.

12. J. Potter, 'Experiments in Rust Removal on a Painted Indian Chintz', in Dust, Sweat and Tears: Recent Advances in Cleaning Techniques Postprints of the UKIC Textile Section Forum, Edited by L. Dawson and M. Berkouwer, 2003, pp. 39-57.

Fig. 11 During testing with 4% agarose gel on the foot cornice.

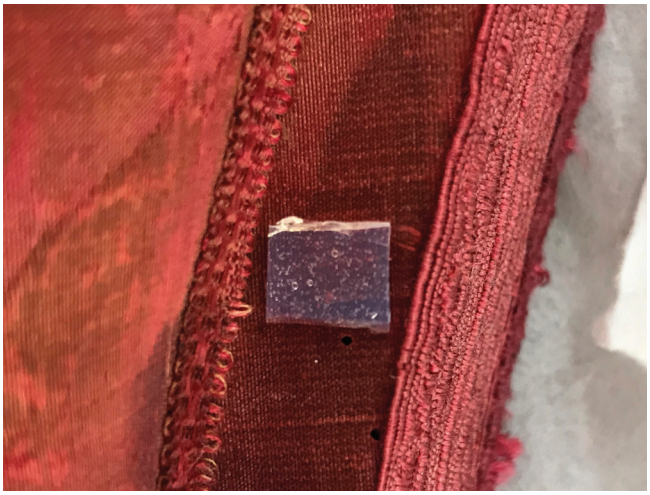

Fig. 12 Tri-ammonium citrate gel treating a water stain.

Fig. 13 The gel drew up yellow soiling.

Animal glue tests

From previous experience the macro image of the darkened adhesive appeared to be aged animal glue (fig. 14). This has limited solubility but research by H. E. Ahmed and F. N. Kolisis, suggested the use of protease from Aspergillus oryzae.[13] The application of the enzyme suspended in agarose gel was considered the preferred method. We chose a 2% Agarose gel, the highest percentage possible to avoid wetting out, although higher than the recommended 1.5% ideally required to allow the enzyme macromolecules to move freely.[14] This enzyme is most active from pH 4.5 to 5.5, and the optimum temperature for activity is 55-60°C,[15] so our treatment at room temperature was far lower than ideal.

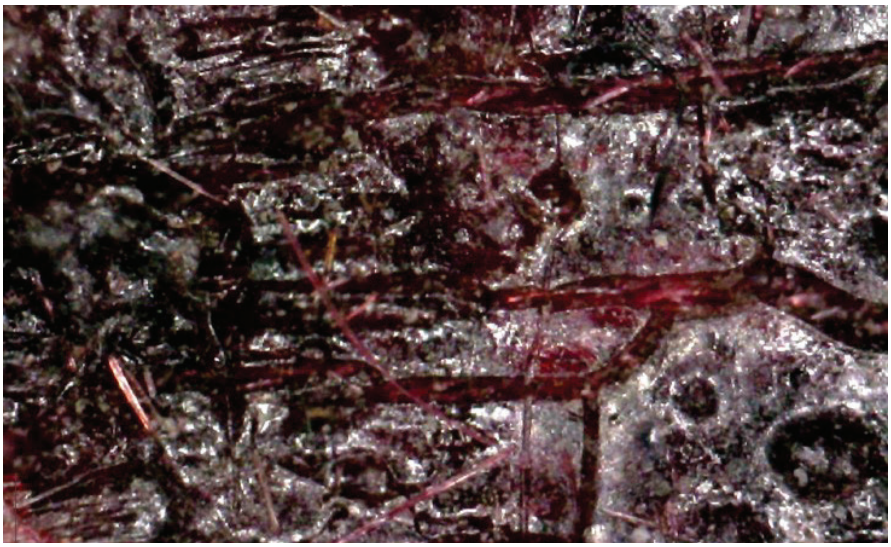

Fig. 14 Macro image of animal glue.

Proteins bind to glass, quartz and polystyrene, causing loss of enzymatic activity. Therefore, all containers and petri dishes used during the preparation and application were made from polypropylene. Steel tools were first cleaned with ethanol. The gel was made as previously described, except that only 90% of the water was used with the gel and the remaining 10% water was added to the enzyme in the petri dish in a fume cupboard to aid mixing. Once the gel had reached 90°C, it was removed from the heat, allowed to cool by at least 10°C, before adding it to the petri dishes of enzyme, swirling the petri dish to mix the solution and trying to avoid bubbles. The enzyme gel is only effective for 24 hours so all our testing needed to be carried out in 1 day.[16]

A Fume Cube extractor was used throughout to avoid inhalation of the enzyme. After 5 minutes, it was observed that the animal glue was tacky. A cotton wool swab dampened with de-ionised water was used to lift some of the adhesive away. A further 5 minutes of the gel being applied resulted in more adhesive being drawn into the gel.

Following the application of the enzyme gel, a 2% agar gel in de-ionised water was applied to the area for the same amount of time, to remove the enzyme. Heating the area with a spatula through silicone release paper was attempted briefly to denature the enzyme but was deemed too damaging to the friable silk fibres.

It was concluded from this trial that a combination of protease from Aspergillus oryzae and agarose gel can be used successfully to remove the animal glue soiling (fig. 15 and fig. 16). The method worked well but the 2% gel wetted out the silk, suggesting smaller treatment areas to allow for wicking. The gel effectively removed the animal glue with little mechanical action but testing to confirm the removal of the enzyme would be recommended before further use.

13. H. E. Ahmed and F. N. Kolisis, 'A Study on Using Protease for Removal of Animal Glue Adhesive in Textile Conservation', Journal of Applied Polymer Science, Vol. 124, Wiley Periodicals, 2012, pp. 3565-3576.

14. Y. van Dyke, 'Agarose-enzyme gels in paper conservation', in Gels in the Conservation of Art, Edited by L. V. Angelova et. al, Archetype, 2017.

15. R. J. Soares de Castro and H. H. Sato, 'Protease from Aspergillus oryzae: Biochemical Characterisation and Application as a Potential Biocatalyst for Production of Protein Hydrolysates with Antioxidant Activities', in Journal of Food Processing, Volume 2014, Article ID 372352, 2014, pp. 1-11.

16. Y. van Dyke, 'Practical Applications of Protease Enzymes in Paper Conservation', in The Book and Paper Group Annual 23, 2004, p. 106.

Fig. 15 Before treating a test area.

Fig. 16 After test.

Infilling

Previous infills and aims for infilling

The 1984 report describes the removal of some original damask considered "too soiled" with a scalpel and patching with damask (from the original curtains). Indian and Thai dupion silk patches were added to infill some larger and numerous smaller areas using Beva 371 film and Beva in white spirit for the edges.[17]

17. Hampton Court Palace Conservation Archive, 1984 and 1986.

Unfortunately, the patches were poorly colour matched and remain very bright, being particularly prominent on the foot cornice which has large areas of patches (fig. 17). The patches often overlap onto the original damask, causing concern over their long-term effect and reversibility. Many of the patches were poorly applied with frayed edges creating a messy finish (fig. 18). The plain, slubbed dupion silk disturbs the visual continuity of the damask pattern. Although infilling of loss does not lower the SOIE rating, the tradition of repair to the bed has historically involved patching and we feel the need to re-do these patches if they can be safely removed and a better alternative could be found.

Fig. 17 Large area of infill patches on the foot cornice.

Fig. 18 A frayed infill patch.

Tests to reverse Beva 371 film

We assumed that all of the patches, based on the 1984 report, were adhered with Beva 371 film.[18] Whilst it is always described as fully reversible we struggled to find case studies in the available conservation literature. We were predominantly concerned with wanting to soften the Beva 371 without affecting the original animal glue, wood or surrounding damask. We used our mock-ups for the initial tests, cutting out sections of damask with a scalpel to reveal the wood below. New Thai silk patches were adhered using Beva 371 film and a heated spatula. Some of the patches were overlapped onto the damask as they are on the cornices, so that we could monitor potential damage to the original damask.

Beva 371 film is usually applied with heat, so our first choice for removal was to raise the temperature above the Glass Transition Temperature (Tg) to 65°C. Heat tests at 65°C were attempted for various durations. The adhesive was not sufficiently reactivated which resulted in tearing the patch and damask (fig. 19). The temperature may not have been high enough above the Tg but any higher would have risked damaging the animal glue so this method was rejected.

18. Hampton Court Palace Conservation Archive, 1984 and 1986.

Fig. 19 Unsuccessful heat reversal of Beva® 371 film.

The Kremer Pigmente technical data sheet 87051 advises Beva 371 film may be soluble in the aromatic solvent hexane, which we sought to avoid for health and safety reasons, and acetone.[19] The Kremer Pigmente data sheet 87032 for Beva Gel suggested it could be softened with isopropanol (ISP or propan-2-ol).[20] We therefore tested acetone first, followed by ISP.

To produce the solvent gel the solvent was poured onto to the solid gel after cooling, rather than during the sol (cooling) phase, to avoid the risk of combustion. It was placed in a petri dish on blotter and the solvent poured over, and left covered for 2 minutes under the Fume Cube. The gel was blotted to remove any excess solvent, placed on the test area and covered (fig. 20). The acetone test was unsuccessful but the ISP effectively softened the adhesive. Reactivation times were refined and we found the test samples needed 20 minutes to easily lift away. Any adhesive residues were removed by heating with a spatula for a second or two through Melinex.

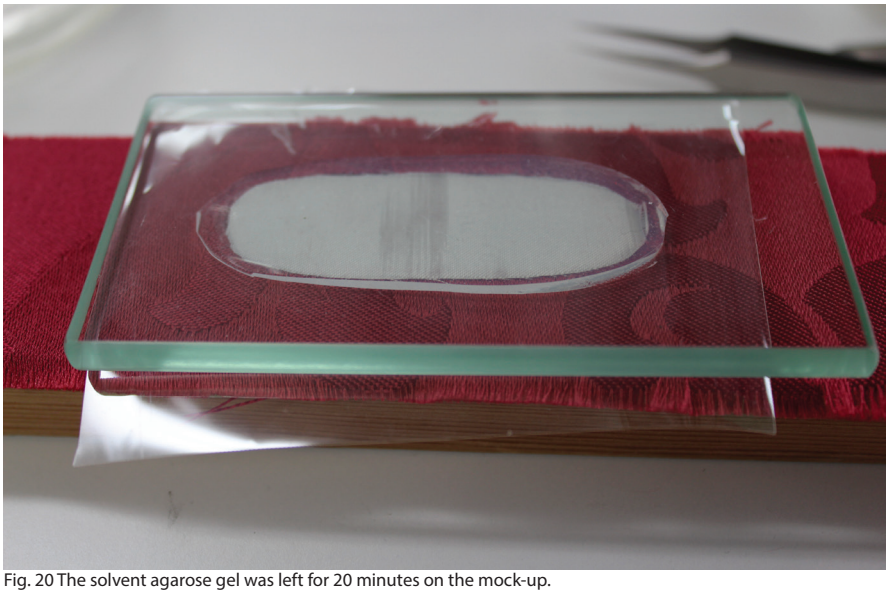

Fig. 20 The solvent agarose gel was left for 20 minutes on the mock-up.

The ISP gel was then tested on the object and the adhesive was reactivated in considerably less time, needing only 8 to 10 minutes before the patch lifted easily away (fig. 21 and fig. 22). We determined this method should be effective in reversing the adhesive without affecting the animal glue, wood or surrounding damask.

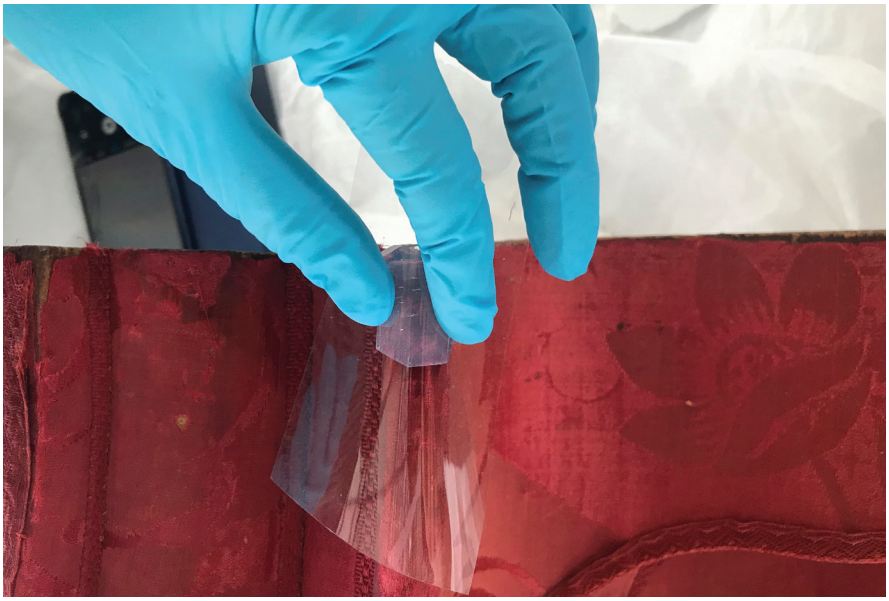

Fig. 21 The ISP gel tested on a patch on the right cornice.

19. Kremer Pigmente, Beva Film Thin (25µm), https://www.kremer-pigmente.com/media/pdf/87050e.pdf (accessed 25/2/2019).

20. Kremer Pigmente, Beva Gel, https://www.kremer-pigmente.com/media/pdf/87032e.pdf (accessed 25/2/2019).

Fig. 22 After 10 minutes the patch lifted away.

New infill trials

The next step was to critically evaluate whether it was possible to infill the areas of loss with an alternative which reflects the quality and standard of the original, whilst visually compensating for the loss of damask pattern. For the purpose of the trials, the largest and therefore most challenging infill was selected, the missing area of damask on the foot cornice.

Endless options were before us, but we needed to limit ourselves to a shortlist for trialling in order to be time efficient. The decision was made to focus on the following three options:

• Using replica damask which we already had in stock in the studio. The damask was woven in the 1980s and used to make new curtains and a counterpane. Whilst the design is the same as the original Hampton Court damask, we were aware that it was significantly different in colour and we also had concerns over the thickness.

• Sourcing a textile which was similar in surface texture to the damask and using dyes to replicate the appearance. After looking through a considerable number of samples in-house, three different silks were selected to trial.

• Using dyes to replicate the damask on paper infills. From a vast range of papers we selected four conservation grade papers to trial due to their similar surface texture and weight to the original damask.

The studio's existing dye recipes were used to dye the three silks to determine whether it was possible to achieve the variations in colour found on the foot cornice. It should be noted that at this stage of the process, the objective was not about achieving perfection as it would be straightforward to make minor adjustments to the recipe further along the project. It was more important to assess the technique within the parameters of an acceptable depth of shade.

Once dyed, it was decided that the taffeta was the closest in terms of sheen and drape to the original damask and therefore, the other silks were disregarded at this point. The studio has for some time been developing the method of using dyes to paint designs onto a textile substrate in order to aesthetically enhance faded or missing areas of the original textile. This method was adapted from the technique described by N. Zagorska-Thomas,[21] for the treatment of a velvet Queen Anne fire screen. A net overlay was dyed using a technique that was designed to accommodate the multi-coloured pattern (fig. 23).[22] Our aim was to determine whether this method could be adapted successfully for the heavier silk.

21. N. Zagorska-Thomas, 'Baskt where it belongs: reproducing polychrome silk painted panels of a costume by L Baskt for S Diagilen's Ballet Russes', in Mind the Gap; ICON Textile Group Forum Postprints, Edited by A. Fairhurst, 2009.

22. M. Jordan and E. Thompson, 'Standing on the shoulders of others: further developments in polychrome patterned nylon net', in Learning Curve: Education, Experience, Reflection; Icon Textile Group Postprints, 2015, pp. 24-32.

Fig. 23 Net painted with dyes ready for steaming.

Lanaset dyes were made up with de-ionised water to produce paint in concentrations of 0.1%, 0.5% and 1% in the red and gold recipes that had been used for the initial dyeing of the fabric. 2% SCMC was added to thicken the dye to achieve the more desirable viscosity for painting. We experimented with different tools and effects to replicate the appearance of the damask. The preferred tools were a combination of short haired brushes to stipple and cosmetic sponges dipped in the dye. Different combinations of dye were trialled on the taffeta, to replicate the ground and design (fig. 24). The four conservation papers were concurrently trialled by painting different combinations of the dye solutions (fig. 25). Once the painting stage was completed, all of the samples were stapled to correx frames and hung inside the dye bath set at 90°C for one hour, to fix the dyes with steam. The samples were then washed to remove the SCMC and blotted before air drying.

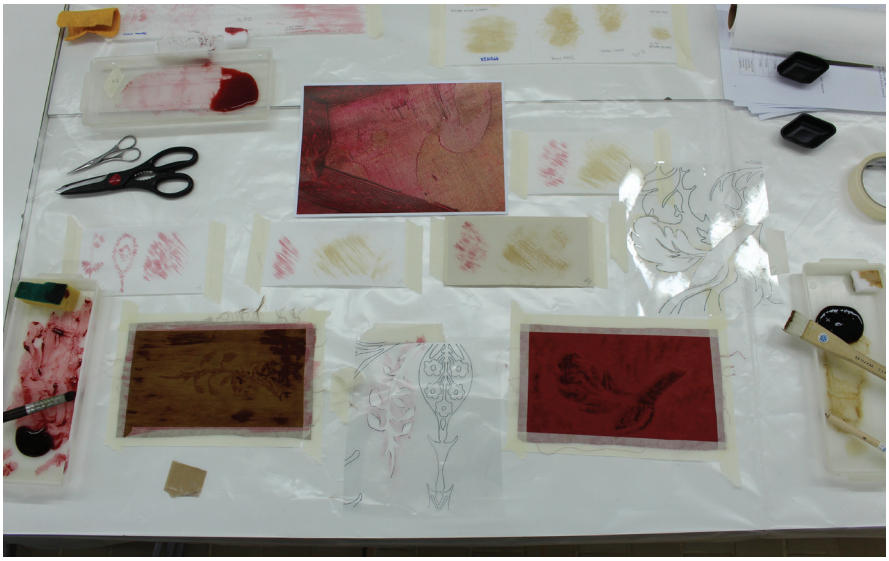

Fig. 24 Lanaset® dye trials.

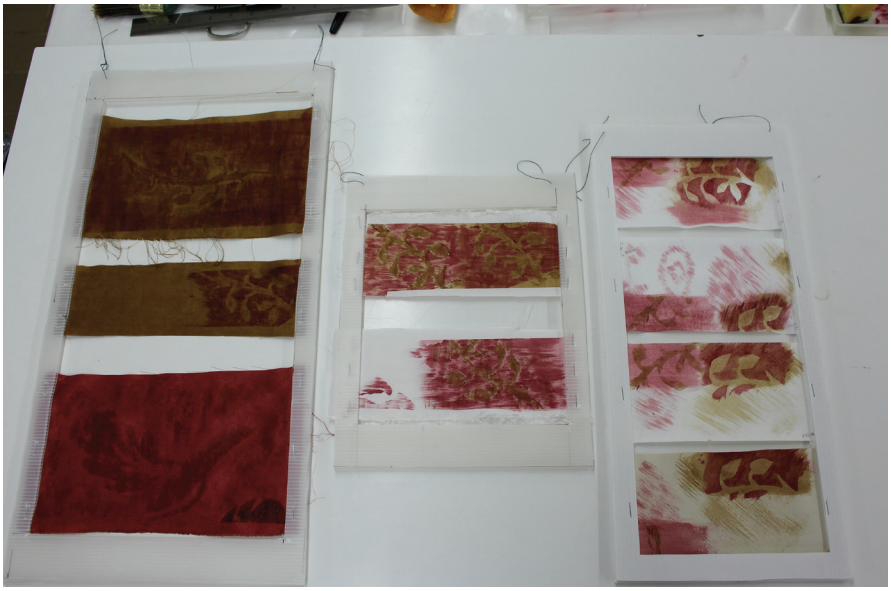

Fig. 25 Silk and paper samples prior to steaming.

From this dye trial, the following was observed:

• Smaller percentages of dye, such as 0.1%, considerably faded during the process. This meant that it was particularly effective for breaking up the look of the new, clean taffeta, giving an aged, slightly dirty appearance to the background.

• 0.5% dye solution was most effective for slowly building up intensity of colour.

• A stencil was made of the damask pattern (fig. 26) and a 1% dye solution was used successfully to paint the outline of the design.

Fig. 26 Stencilling the damask pattern to scale.

It was surprising to find that there was not a significant difference in the appearance of the painted dye on the taffeta before and after steaming. The colours did not merge as we had expected. Regarding the paper samples, whilst we were able to achieve better control and even application of colour, they were found to lose their depth of shade and 'sheen' after steaming, making their appearance less similar to the damask. The option of paper as a suitable infill was therefore rejected.

As a result of these observations, it was decided that the taffeta was the most sympathetic option; pre-dyed with the red dye solution before painting with different solutions of the red and gold dyes. One further trial was carried out with a slightly different depth of shade to knock back the colour slightly, allowing the damask design to be more visible. A spare strip of the pre-dyed red silk was used to practice the technique and act as a 'palette' for checking colours and removing excess dye.

This method worked well and produced a subtle effect (fig. 27). The dye recipe used for the piece dyeing was the correct depth of shade. However, the results show that the dye recipe requires further adjustment to achieve the perfect colour.

Fig. 27 The final test blends well without being misleading.

Previous repair and consolidation

The damask and braid on the cornices and corbels have many small areas of missing and lifting fabric which are vulnerable to further loss if left untreated. In 1984 loose damask was effectively re-adhered and consolidated with Klucel in a 9:1 mixture of acetone and water. There was also a support with crepeline and wheat starch paste which immediately failed.[23] Although new tests have been carried out in our current treatment work, we aim to avoid introducing different adhesives unnecessarily. A very similar consolidation mixture of Klucel was used in 2017 on the finials and further adhesive repair will be needed on the cornices and corbels.

23. Hampton Court Palace Conservation Archive, 1984 and 1986.

Conclusion

Until very recently, upholstered elements of the state beds and throne canopies in our collection would have been limited to a treatment proposal of little more than surface cleaning and consolidation. When commencing a project such as this, it is anticipated that a proportion of the trials will be unsuccessful. However, we considered all findings to be invaluable in expanding our knowledge within the studio. We were surprised at the efficacy and adaptability of gel cleaning in targeting the different types of soiling and expect good results during the full treatment. Further testing on the removal of gel additives following treatment would be of considerable interest as this has not yet been adequately addressed. Enzymes in particular still pose a question as to the true extent of their continuation, despite their unstable nature, with opinions widely varying within specialisms.

Due to the ease of application and reversibility of Beva 371 film, we have decided to continue using this to apply our new infills. Finding an appropriate infill technique provided a fun opportunity to employ our creativity and will subtly enhance the overall impression of the foot cornice in particular. We find that the use of gels and painted dyes can sit alongside more traditional treatment methods and we will consider these options for the other composite elements of the bed.

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Sigma-Aldrich Company Ltd.
https://www.sigmaaldrich.com/catalog/product/sigma/a9539?lang=en&region=GB

EDTA disodium salt dihydrate
BDH
https://uk.vwr.com/store/catalog/product.jsp?catalog_number=20309.296

Tri-ammonium citrate/ Ammonium citrate tribasic
Alfa Aesar
https://www.alfa.com/en/catalog/A16973/

Enzyme - Protease from Aspergillus oryzae
Product: P6110 Sigma-Aldrich
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AP Fitzpatrick
https://shop.apfitzpatrick.co.uk/beva-aa-371-films-413-c.asp

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Pongees
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