Taking the Rough with the Smooth:
Issues and Solutions for Decorated Surfaces.

Forum of the ICON Textile Group

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THE INSTITUTE OF CONSERVATION

Contents

Posters

Foreword

The forum highlighted the challenges faced by textile conservators when dealing with surface decoration which is often non-textile. Papers included identification and conservation aspects of different types of paint media, orchestrating the conservation of a heavy but fragile wall hanging, collaboration with conservators of materials beyond textiles and innovative three-dimensional textile mapping.

Problem solving through cross disciplinary collaboration was a common theme running through the forum presentations. Sharing the results of forays into unfamiliar but extremely useful collaborations helps contribute to the growing pool of knowledge available and may provide the vital clue to solve a fellow conservator's problem.

Grateful thanks to all the contributors and the Textile Group Committee for a very interesting and successful forum.

Vivian Lochhead, *Senior Conservator at the People's History Museum, Manchester*
Forum chair

Taking the Modern with the Traditional: Introducing the Challenges of Acrylic Emulsion Painted Banners

Leanne C Tonkin
Textile Conservator, People's History Museum, Manchester

Introduction

The People's History Museum (PHM) holds a large collection of traditional oil-based painted banners, such as trade union banners, which are predominately on silk textile grounds. It is perhaps this aspect of the PHM collection that is more commonly known. The museum also holds a good number of banners, flags and other flat textiles which are painted with modern paints, such as household, industrial and acrylic-based paint media. These banners represent much of the modern facet of the collection and they range from the mid twentieth to the twenty first century and this proportion of banners is expected to increase in the future. The use of modern paints such as, acrylic emulsion paint, have become increasingly popular with artists over the last sixty years because of their versatile properties. Some of the reasons these synthetic paints have become so popular since the 1960s is because they offer great clarity, phenomenal elasticity and can be painted directly onto supports (Jablonski *et al.* 2004); properties modern banner makers would find very beneficial. The last decade has seen a significant rise in conservation literature regarding the issues in treating modern paints, specifically relating to contemporary and modern art. A vast amount of work has been done into investigating the characteristics and properties of modern paints, as well as trying to determine the effects of the environment and conservation treatments. This research continues and is primarily lead by institutions such as Tate, London, UK and the Getty Conservation Institute, Los Angeles, USA.

This paper aims to introduce the challenges of modern painted banners, specifically acrylic emulsion paints, posed to the textile conservation team at the PHM. The paper will introduce the characteristics and properties of acrylic paints from literature reviews, specialist talks and discussions conducted at the Textile Conservation Studio (TCS) at the PHM. Elemental differences between a traditional oil-based painted silk banner and an acrylic emulsion painted synthetic banner using X-ray fluorescence (XRF) will be discussed, also initial observations regarding the differences in deterioration patterns will be reported. Several case studies from the PHM's collection will be presented to help introduce the dilemma of treating acrylic painted banners which may help to contribute towards initiating a textile conservation perspective with regards treating modern paints. Much of the research and practice led workshops, in particular the cleaning of acrylic emulsion paints, has been aimed at conservators working with modern and contemporary paintings and fine works of art relating to this area (Ormsby *et al.* 2006; Ormsby *et al.* 2007a; Ormsby and Learner 2009; Ormsby and Smithen 2010; Kampasakali *et al.* 2011).

Introducing Acrylic Paints and their Characteristics

Modern paints, such as the types mentioned in the introduction, have been widely used by twentieth and twenty first century artists. Unlike traditional oil-based paints, there is relatively little known about their physical properties, how they age under standard museum conditions and their long-term response to conservation treatments (Learner 2007: 4; Ormsby *et al.* 2007b: 249). Acrylic emulsion paints have been widely used since the 1960s in the UK. They have desirable and beneficial properties, including rapid drying, versatility, durability; they do not separate and can be thinned by water. Acrylic emulsions are known to exhibit high resistance to UV degradation (Jablonski *et al.* 2004). The relatively soft, thermoplastic properties of this type of paint media

results in great adhesion and flexibility (Smithen 2007: 167). It is understandable that contemporary banner makers, like contemporary artists, have also recognized these qualities as being an appropriate choice for flexing textiles used as visual reinforcements for demonstrations and public gatherings. The clean, bright and pure colours of acrylic paints would enable the banners to be noticeable from a distance. Further benefits of using acrylic emulsion paints (compared to oil) is there is no need for careful and time consuming preparation layers on the substrate before the paint is applied (Learner 2007: 7). This aspect of the painting process would certainly seem advantageous from the banner-makers' and clients' points of view as many banners would often be required quickly and therefore made in haste.

Acrylic paint exists in two forms; acrylic solution and acrylic emulsion. Acrylic solution paints are bound in a poly n-butyl methacrylate polymer and are made with hydrocarbon solvents, for instance turpentine, so they remain resoluble in the carrier solvent when dry but are unaffected by water (Jablonski *et al*: 2004; Learner 2007: 4, 5). Acrylic emulsion paints are formulated differently (see next paragraph). The polymer is dispersed in water with the aid of surfactant and other additives, is not soluble in water once dry but undergoes swelling when exposed to water and other solvents (Hayes *et al.* 2007: 58; Kampasakali *et al.* 2011). Early acrylic emulsions contained the co-polymer poly ethyl acrylate/methylmethacrylate (p(EA/MMA). Since the 1980s many of the resin formulations changed to a poly n-butyl acrylate/methylmethacrylate (p(nBA/MMA)) co-polymer making the paint film more durable to outdoor exposure (Jablonski *et al.* 2004; Learner 2007: 5).

Acrylic emulsion paints undergo a complex drying process known as polymer coalescence. When the paint is in liquid form, the acrylic co-polymer droplets are held in suspension within the water phase with added pigments, extenders and a number of other additives that influence the properties of the paint such as stability. As the water evaporates during drying, the co-polymer particles are drawn closer together. These particles then weld to form a 'honeycomb' network, forming a continuous film (Ormsby and Smithen 2010: 7; Ormsby and Learner 2009: 29). Therefore, technically, acrylic emulsion paints are dispersions rather than emulsions. This drying process can take up to three months and it is during this time that acrylic emulsion paint can remain resoluble in water (Learner 2007: 7; Ormsby and Learner 2009: 29). Developments in waterborne acrylic paints continue and their ingredients are many and complicated.

Acrylic paints are very flexible at room temperature, they have a low glass transition temperature of around 10°C (Ormsby *et al.* 2007b: 249) and are therefore responsive to changes in temperature and RH; making the films vulnerable to dirt and airborne pollutants as well as inappropriate packing and handling. As mentioned previously, surfactants are used in the manufacturing process as stabilizers. It is a well known observation amongst painting conservators and conservation scientists who work with acrylic emulsion paintings that these surfactants migrate to the surface of the acrylic emulsion paint film and this results from the migration of poly ethoxylate (PEO) based surfactants contained within the bulk paint film (Ormsby 2007a *et al.*: 192; Ormsby 2009; Ormsby *et al.* 2009: 33; Ormsby and Smithen 2010: 8). This migration of surfactants to the surface combined with the attraction and retention of dirt generally results in a decrease in surface gloss and colour lustre. PEO-based surfactants appear as matt crystals on the surface and are water-soluble and can be readily removed from paint surfaces with swabbing treatment using water (Ormsby and Learner 2009: 34).

Surfactant moves back to the surface over a period of time after it has been cleaned. It is a repetitive process and how long this phenomenon lasts and the reason behind it is still not really understood. This is currently causing ethical debate amongst conservators having to treat and investigate acrylic emulsion painted surfaces as to whether or not the surfactant should be removed as it does not guarantee a surfactant-free surface in the near future and the surfactant

forms part of the original paint material. Repetitive cleaning and the effects this has on what is a water sensitive media, still needs to be explored. For instance, does the repeated removal of the surfactant cause decreased flexibility or contribute to the long-term deterioration of the paint film? It has been noticed that early acrylic paintings show major amounts of surface surfactant, in comparison to newer acrylic paints made from the 1980s onwards (Ormsby and Learner 2009: 34).

A further dilemma regarding the wet-cleaning of acrylic emulsion paints is that they are water sensitive, they swell dramatically when they have been exposed to water due to significant amounts of water-extractable surfactant remaining in the bulk film. Polar solvents, such as acetone and ethanol, are also known to cause severe swelling (Figure 4). The surface morphology of the paint film has been known to swell by 150%[1]. There are many factors which can influence this, for instance, the amount of water-soluble materials present, polymer composition, film drying conditions and film age (Ormsby and Learner 2009: 33). Other variables are pigment type, and brand of paint (Ormsby *et al.* 2007a: 195). All these factors make aqueous cleaning difficult.

Experiments with X-ray fluorescence (XRF)

Elemental analysis was undertaken using a hand-held X-ray fluorescence unit[2] on a synthetic textile acrylic emulsion painted banner which was on display at the PHM. For comparison, a traditional oil-based painted banner on a silk ground, which was being worked on in the TCS, was also analyzed. This experiment helped to reinforce the different elements which can be present between these two different paint media on textile substrates. Another advantage of using these two particular banners was that they had not undergone any conservation treatments, such as consolidation, where this may have obscured the results. However, the silk layer and any preparation layers applied to the oil painted banner and the effects of the synthetic textile ground combined with the acrylic paint would have to be taken into consideration when looking at the results of the spectra in any detail. Further considerations include dirt and grime layers which may have been present at the time of analysis.

Figure 1 shows the results taken from various areas of the oil paint on the silk banner and figures 2 and 3 show the results taken from the synthetic acrylic painted banner. On the oil painted silk banner there is a high level of lead, some mercury, and traces of gold and silver present in the paint media. These are elements which can be commonly detected in oil painted banners. The acrylic painted synthetic banner displays high levels of iron, indicating iron-based pigments, traces of chromium, calcium, copper, and zirconium. The additional spectrum shows high levels of titanium (Figure 3). All these elements have been commonly found as additives in modern paints. The high level of iron found in the acrylic painted banner raised some questions regarding the future deterioration of synthetic textile ground[3]. Further concerns relate to analysis conducted by Tate and the Getty Conservation Institute which suggests a possible link between the presence of surface surfactant and organic and iron-based pigmented films (Ormsby *et al.* 2008: 869), however, this needs to be explored further. This analytical exercise has highlighted the necessity for further investigation to help establish a better understanding of the characteristics of modern painted textiles, especially as many of the banners have been exposed to all manner of conditions and phenomena, all of which will ultimately inform the practice of textile conservation.

Confederation of Health Service Employees: Banner Case Study One

The Confederation of Health Service Employees Banner, otherwise known as the COHSE national banner, was designed and made in 1978 by Toye, Kenning and Spencer (Gorman 1986: 184), a well known twentieth century banner-making company. The banner is a single layer synthetic twill

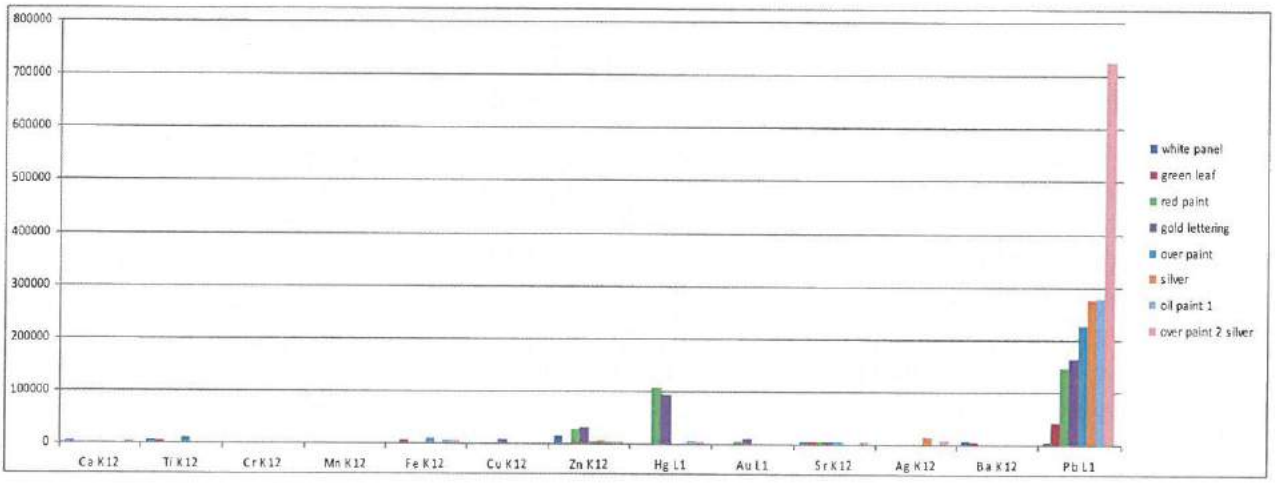

Figure 1

X-ray fluorescence (XRF) analysis of various regions of a traditional oil-based painted banner.

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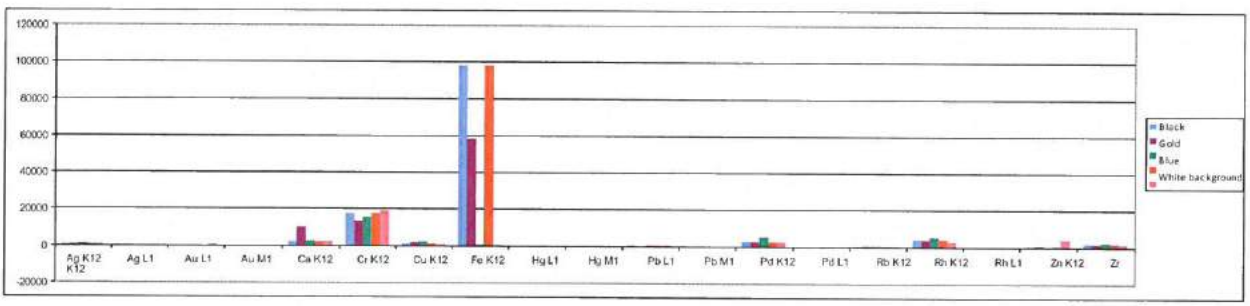

Figure 2

X-ray fluorescence (XRF) analysis of various regions of an acrylic emulsion painted banner.

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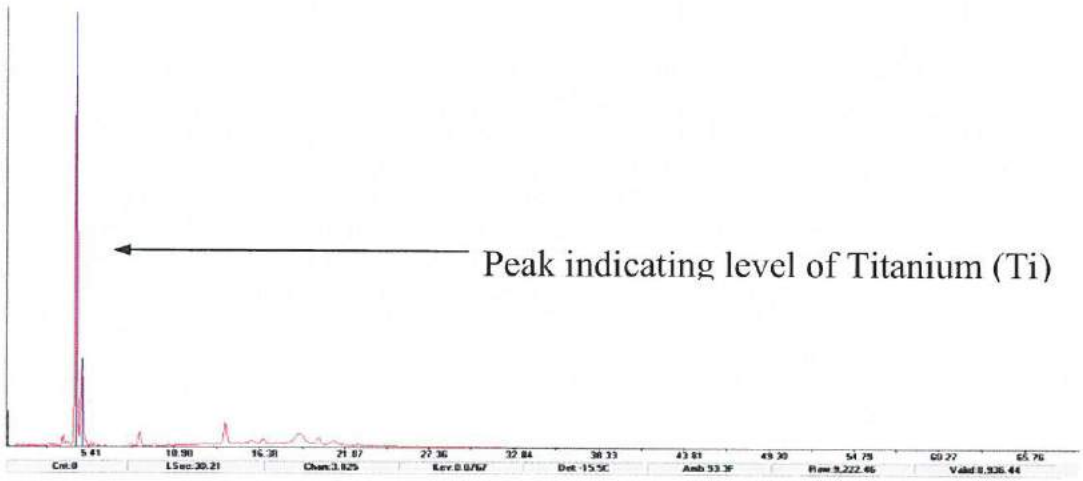

Figure 3

X-ray fluorescence (XRF) analysis of the high level of Titanium present in an area of the emulsion paint on a banner.

© People's History Museum

woven banner (possibly polyester) painted on both sides to occupy identical areas on each side of the ground layer in acrylic emulsion paint (Figure 5). It was first treated in 2008 during the author's student work placement at the PHM when initial research regarding the difficulties of wet-cleaning acrylic paints was just emerging. Therefore, a dry-cleaning approach was adopted. A dry cleaning sponge, followed by dry brushing with a very soft brush was used to surface clean the painted surface. This technique helped reduce patchy white haziness which had occurred on the paint's surface, most likely due to the migration of surfactants from the paint film. Corrugations and hard creases were reduced by applying contact humidification to the whole of the banner. The humidification treatment proved to be very successful. However, now knowing the effects water can have on acrylic films, the success of the treatment in the painted areas may have been as a consequence of the swelling of the acrylic emulsion paint. Current research regarding the long-term effects of the swelling characteristic in acrylic emulsion paints remains unknown. The use of dry cleaning sponges also poses problems as the abrasive effect can push the dirt into the paint film and has a tendency to burnish paint surfaces (Ormsby 2009).

During the treatment of the COHSE banner patterns of deterioration were examined. There were regular occurrences of horizontal fractures on the painted surface in areas where the painted surface was narrow (Figure 6). The fractures went through all layers of the paint-textile-paint layer severing the synthetic textile substrate. The surrounding textile area remained unaffected. The fractures may be due to perhaps the banner being rolled during its use and survival as an active textile, however examples of horizontal fractures on other acrylic emulsion painted textiles and stretched easel paintings executed in acrylics has been observed. The stability of the unpainted synthetic textile ground has been noted in most of the acrylic emulsion painted banners that have been treated at the PHM; areas where the painted surface meets the soft textile seem stable. The current condition of acrylic emulsion painted banners provides a stark contrast to the deterioration patterns of traditional oil painted banners, mostly on silk textile grounds, where the areas of soft textile meeting the hardness of the oil painted surface cause all kinds of problems, for instance, the hardness of the paint's edge encouraging the severing of the silk as if it had been cut with a sharp blade. The seemingly stable characteristics of acrylic emulsion painted banners could be due to a number of factors: the stability and flexibility of the acrylic paint accommodating the flexing textile ground; synthetic textiles having a stronger resistance to the acrylic paint or simply, these banners have not aged enough to display any kind of severe deterioration.

During the author's student work placement the fractures were treated by applying small silk crepéline patches coated with Klucel G® (4% in water) and Beva® 371 in white spirit as bridges and applied with very low heat activation. Klucel G® in water was selected because the bridges were less noticeable. The treatment worked well and is still stable. But as current research continues to emerge about acrylic emulsion's sensitivity to water and most other solvents, avoiding any aqueous based adhesive, such as Klucel G®, would be preferable. Beva® 371 diluted with lots of white spirit would be considered more appropriate, although the long-term effects of this treatment strategy would also have to be monitored[4]. White spirit causes little effect on acrylic emulsion surfaces but is not efficient as a cleaner due to its low polarity. If necessary, heat activation should be used at a very low temperature due to the thermoplastic properties of acrylic emulsion paint.

Great Britain Labour Party; Labour League of Youth: Banner Case Study Two

The Great Britain Labour Party: Labour League of Youth banner was treated in 2011 and is a mid twentieth century double layered rep woven synthetic banner (Figure 7). It has been painted on one side in acrylic emulsion paints. Much of the original paint has been lost exposing the synthetic

textile ground. The white background to the central image has lost up to 98% of the paint leaving behind a powdery residue (Figure 8). Again, this deterioration may be due to exposure to the outdoor elements when it was used and the paint has deteriorated over time during its survival. A further dilemma is the thermoplastic characteristic of the acrylic emulsion paint combined with the smoothness of the tightly woven synthetic textile ground. This means little penetration occurs between the two components, especially if no preparation layers have been applied to the textile ground before hand which helps with stability and adhesion of the paint layer. A droplet of de-ionized water was placed on the surface of the white paint using a pipette. This is a test regularly undertaken by painting conservators to establish the presence of surfactant within the paint film. The droplet remained on the surface indicating there was no surfactant present in the paint; it could also mean there is a layer of greasy grime preventing the water getting it. In fact, a number of acrylic emulsion painted banners have produced the same result of no penetration, indicating no presence of surfactant in the bulk film. This could also be due to these paints being exposed to all manner of conditions and phenomena whilst in use, certainly if the banners have been used soon after they had been freshly painted and the paint film was still soluble in water, and as a result the surfactant has reached the end of its mechanical action of migrating out of the paint film causing severe levels of deterioration.

Despite the acrylic paint having aged and dried it is still sensitive to swelling if exposed to water, although to a lesser extent compared to un-aged paint (Ormsby and Learner 2009: 32). Influenced by the level of deterioration of the paint surface, swab cleaning was eliminated from the treatment process to avoid further change in the characteristics of the paint film. The decision was made to reduce the treatment processes and to only consolidate the paint fragments with a Beva® 371 and white spirit solution[5]. This was left to dry over-night and no heat activation was necessary. Potentially, dirt particles have been trapped on the surface of the paint but the reduction of treatment processes seemed to be a far safer option in order to preserve what was left of the paint rather than run the risk of losing it. Areas painted in a black pigment showed signs of a white haziness, due to migrating surfactants coming to the surface of the film (Figure 9). Swab cleaning with water to help remove the surfactant was, again avoided to prevent roughening the surface. This can occur depending on the amount of surface surfactant present (Ormsby and Learner 2009: 32) and large amounts were recorded on the small surface area of the black paint. Another consideration relied on the knowledge that the surfactant is likely to migrate again to the surface and the long-term consequences of this repetitive process, certainly on flexing textile substrates, remains unknown. Consolidation was then considered as a way to trap the surfactants and prevent further reactions in the bulk film. During testing, the Beva® 371 and white spirit solution seemed to either disperse the surfactant back into the paint film or the surfactant dissolved in the Beva® 371 solution. The final decision was made not to treat the black painted areas as they were stable in comparison to the other areas of the painted surface and did not warrant consolidation. This area may be revisited in the future when better cleaning options for textiles painted with this medium are established.

Amalgamated Stevedores Labour Protection League: Banner Case Study Three

The final case study is the Amalgamated Stevedores Labour Protection League banner, which is a traditional silk oil-based painted trade union banner produced by George Tutill (Figure 10). Tutill was an established banner-maker in early nineteenth century Britain and his company continued to thrive long after his death. The banner is dated to around 1918 and has undergone extensive restoration work during the 1970s by the banner making company Turtle and Pearce. It was decided to keep and maintain the restoration work because the work was stable and the textile was not undergoing any major deterioration. This decision complicated the cleaning strategy. The

treatment would have to consider the synthetic restoration tape and the under lying adhesive used to adhere the tape (Figure 11). Considerations would also have to extend to the areas where modern paints had been used extensively throughout the painted area on the banner during its restoration. This really limited what could be done in terms of humidifying or wet-cleaning due to the potential presence of acrylic-based paints. Some of the paint was identified as most likely being acrylic solution as it readily dissolved in industrial methylated spirit (IMS) when tested with a tiny swab. This confirmed that paint was a modern paint and was in keeping with the date of the restoration work. Therefore, the rest of the over-paint was assumed to be either acrylic solution or acrylic emulsion paint. These paints had been used to over paint areas which had lifted away from the primed silk ground causing areas of disfigurement. The restoration tape and zigzag stitching which had been applied to repair tears had been well over painted to conceal their positioning.

Contact humidification was conducted only on the textile areas, avoiding the painted surface. The painted surface was wet-cleaned with very gentle swabbing using cotton swabs and a one percent detergent solution[6]. The detergent solution was removed with further swabbing using de-ionized water to remove any residue. Areas of over paint, where possible to see under strong light, were avoided. The restoration tape which could have been painted with acrylic solution or acrylic emulsion paint was swabbed cleaned with de-ionized water only and immediately dried afterwards with a dry cotton swab. Research undertaken at Tate concludes that up to one minute swabbing with water is considered relatively safe as it appears to create very few changes to the physical properties of acrylic emulsion paint film (Whitehouse 2011: 44). Often it was difficult to see just where the areas had been over painted. For instance, swabbing an area which depicted the sea in a multitude of blues and greens proved problematic. Significant pigment transfer from a green pigment was observed, possibly resulting from higher quantities of surfactant and/or other water soluble materials in the potentially newer modern paint. Swabbing in this area was stopped. Overall, this cleaning system proved efficient in removing soiling from the painted surface.

Current research is looking in to the measure of pH and conductivity (measure of ions) working with various recipes involving solvent–surfactant–water combined cleaning systems which has been shown to slow the swelling down and is effective at removing surface soiling. Perhaps this may offer a way forward for the future in conserving acrylic emulsion painted textiles.

Concluding Thoughts and Considerations

Ongoing modern and contemporary art research based on the characteristics and cleaning of acrylic emulsion paint has been fundamental in raising issues and informing treatment strategies for acrylic emulsion painted banners at the PHM. The desirable properties found in acrylic emulsion paints make them difficult to conserve because of their complex ingredients. Extensive use of banners, their exposure to all kinds of phenomena and their subsequent survival introduces further dilemmas when thinking about the conservation of acrylic emulsion painted banners. For instance, the physical damage and possible changes which have occurred to the characteristic of the acrylic emulsion paint over time. Further analytical work is essential to enable a better understanding of their composition and condition which will ultimately inform textile conservation practice. A minimal approach should be considered where possible by reducing the treatment processes in an attempt to preserve the seemingly reactive nature of acrylic emulsion paints on textile grounds which have been exposed to outside environments such as banners.

Acknowledgements

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Notes

1 Personal communication (talk organized by ICON Paintings Group) with Professor Richard Wolbers, Associate Professor, Coordinator of Science and Adjunct Paintings Conservator, Winterthur Museum, University of Delaware, USA, on 28 June 2011.
2 Handheld Tracer III-V was used which provides portable X-ray Fluorescence Spectrometry enabling in-situ analysis.
3 Personal communication (meeting) with Vivian Lochhead, Senior Conservator, People's History Museum, Manchester, UK on 27 March 2012.
4 Personal communication (e-mail) with Annette King, Painting Conservator, Tate, London, UK on 13 December 2012.
5 An approximate ratio of 25:75, Beva/White spirit solution was used.
6 The PHM still has stock of Synperonic™ N detergent even though this has been withdrawn from usage due to environmental concerns. Synperonic™ N was used on this occasion due to its past success at removing soiling from oil-based painted surfaces.

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Suppliers

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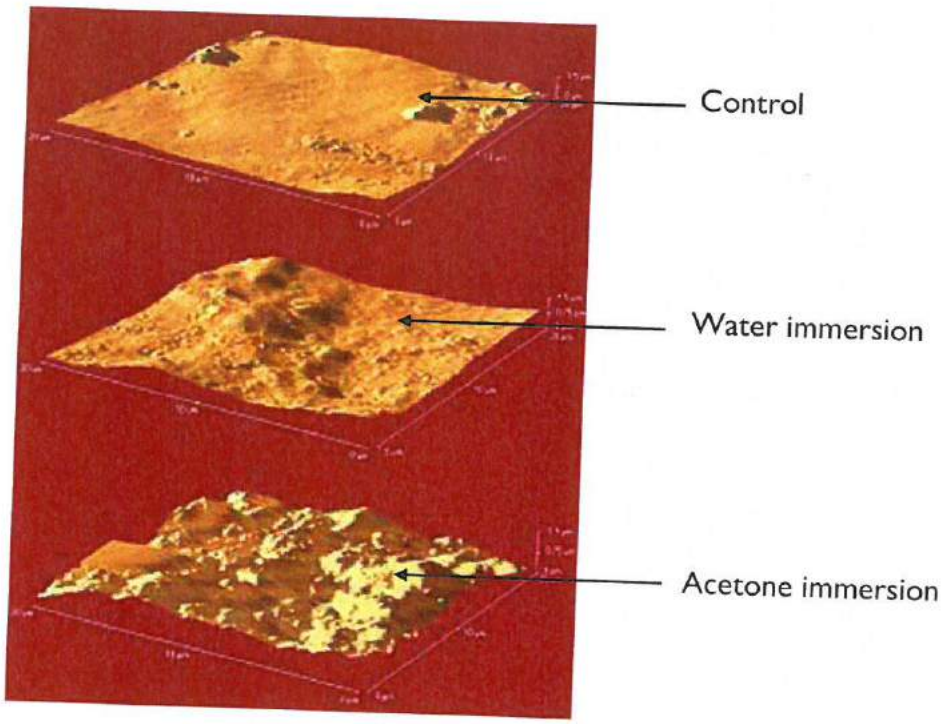

Figure 4
Atomic Force Microscopy (AFM) images showing the swelling behaviour of samples of acrylic emulsion paint after prolonged exposures to water and polar solvents, such as acetone.

Original source: Tate papers, Tate's on-line research journal: Ormsby B. et al. (2006). The Effects of Surface Cleaning on Acrylic Emulsion Paintings: A Preliminary Investigation http://www.tate.org.uk/research/tateresearch/tatepapers/06autumn/ormsby.htm Accessed 28. 3. 2011
Tate, ©X-AT, University of Exeter, 2003

Figure 5
Confederation of Health Service Employees Banner, c.1978. A synthetic banner painted with acrylic emulsion paints
© People's History Museum

Figure 6
Horizontal fractures on the acrylic emulsion painted surface
© People's History Museum

Figure 7
Great Britain Labour Party: Labour League of Youth banner, mid 20th century synthetic banner painted with acrylic emulsion paints

Figure 8
Areas of severe loss of acrylic emulsion paint

Figure 9
Migrating surfactant on areas painted in a black pigment

Figure 10
Amalgamated Stevedores Labour Protection League banner, c.1918. The banner underwent restoration work in the 1970s

Figure 11
Example of restoration tape over painted with modern paints

Powdery paint: The use of funori with an Indian Jain painting

Miriam McLeod
Textile Conservator, National Museums Scotland

Introduction

Painted textiles come in many different forms, and a wide range of consolidants and treatment methods have been devised to suit their various properties and needs. Though not commonly used in textile conservation, funori, a naturally occurring polysaccharide seaweed, has useful and distinct properties which make it a highly suitable choice for consolidating matte, powdery paint. Bermocoll is a water soluble ethyl hydroxyethyl cellulose with good flow properties for binding larger flakes. Both of these consolidants were recently employed to stabilise a 19th century painted wall hanging from India which was required for long-term display in the newly refurbished National Museum of Scotland (NMS) in Edinburgh. The hanging is painted with a thick layer of matte pigment, and as such presented an issue of consolidant choice due to its non-reflective surface, and the deterioration of much of the uppermost paint layer to a friable powder. This article outlines how the conservation treatment was formulated and carried out with reference to the use of funori in other contexts. Some background to the object will be given about its construction and condition, and why and how funori was chosen as the main consolidant.

Funori has been successfully applied as a consolidant to matte paint on paper, paintings and wood. It has been less routinely used for painted textiles, although to some extent this may be because this type of paint medium on textile objects is relatively uncommon. Aside from its current use with historic artefacts however, matte paint consolidation may be undertaken more often in future, since it is a medium frequently used by modern artists in their work. The Jain painting was one of hundreds of objects that were selected for long-term display in the newly refurbished galleries of the National Museum of Scotland (NMS) in Edinburgh.

Before Conservation

The hanging consists of a painting on sized cotton measuring approximately 2.30 x 1.11 metres. It is believed to originate from Gujarat, and is loosely dated to the late 19th century. Nothing further is known about its provenance. The whole subject of imagery in Jain art is quite complex, but the NMS Jain painting (Figure 1) is within a category which are concerned with depicting Jain cosmography. Jains believe that Jiva – an immortal and indestructible soul – is within every living being. This principle underlies the Jain perception of the cosmos, which has an intricate structure. Symmetry and order are significant to the layout of such paintings, and aim to calm the viewer and disengage him from the chaos of the natural world. This painting depicts the journey of the soul and its place within the greater cosmos, and represents the Jain universe including the three worlds. At the very top is the abode of the liberated souls; below is the diamond shaped world where deities exist. The thin strip between is the earth where humans, animals and plants reside. Below is the lower world of seven hells, shaped as a pyramid, where beings are tormented both by demons and each other (Voight 2010).

The cloth and painting would have been prepared and painted in a specific sequence, described in Shridhar Andhare's book, 'The Peaceful Liberators' (1994: 78) as follows:

> *"The cloth is first primed with wheat or rice flour paste to fill up the pores of the textile. Use of tamarind-seed paste is also recommended in certain cases. After the priming is completely dry, the surface is burnished with an agate burnisher to ready it for painting. The outlines are drawn first,*

(usually in red), and then the colours are applied. Additional decoration in gold or silver and the inscription of mantrakshara (mystic symbols) and identification labels in black or red are completed at the end."

Condition

Certainly, the description of a fairly weak size such as wheat or rice flour paste was consistent with the condition of the painted surface before treatment. On examination it was quickly apparent that the pigments in the painting were only very weakly bound to the cotton ground cloth. The entire paint layer was extremely friable, with powdering, flaking and loss apparent throughout all the pigments over the entire object. The green, vermilion, red lead and mixtures of these pigments were particularly powdery and vulnerable to further loss; this is especially visible along crease lines and folds, but also in the detail of the images themselves.

Even without magnification, the paint looked very powdery, suggesting the uppermost particles were probably highly mobile. The dog in the lower proper right of the hanging has almost completely lost the original red-brown colour of his coat (Figure 2). Unfortunately, closer examination under x10 magnification helped reveal there was almost as big a problem with pigments that were cupping and flaking. The whites, which include lead white, calcite and anatase, as well as the red lake and certain other colours achieved by mixing, were often very chunky and loose. The detail image of a man with a monkey's head illustrates clearly how significant the effect was in parts (Figure 3); the loose particles pictured were only just holding on to the ground cloth.

A different problematic element concerning the condition of the object and it's future treatment was that it was covered with a thick layer of heavy dark grey dirt soiling, much of which is ingrained, but which was also clearly visible lying over the entire surface of the object.

In summary, the preliminary examination revealed some serious condition issues. The original size was evidently failing, and all colours were exhibiting widespread powdering, crumbling and flaking throughout. In addition the substrate was extremely dirty, and rather dry. Normal preparatory surface-cleaning by vacuum suction however, could not take place due to the risk of accidentally removing paint particles.

Analysis

A more incidental but nevertheless significant consideration was the vivid green used on a large part of the ground, which looked suspiciously like Emerald Green, a highly poisonous green pigment containing arsenic. Despite their toxicity, arsenic compounds were commonly used in domestic textiles and wallpapers in Western Europe and elsewhere during the early-mid 19th century. The practice of using arsenic in domestic goods only ceased in part due to the illness or deaths of children and adults who had accidentally consumed it by a number of means, including absorption through the skin, inhalation or ingestion. Positive identification of the pigment was therefore carried out by Susie Kirk, conservation scientist at NMS using Scanning Electron Microscopy (SEM), with the result that treatment was carried out using Nederman extraction, and wearing safety goggles, gloves and laboratory coat at all times.

The SEM analysis not only confirmed the presence of copper aceto-arsenite (quantification of which indicated twice as much arsenic to copper), but the presence of lead in the pin-head sized samples. This suggested there could be a lead base under the paint layer, which is seen as the white element of the SEM image. The binder could not be identified from this sample other than to confirm it was of organic origin. The micro-structure shows the surface is very broken up and crystalline, indicating the lack of cohesion between the elements and the failure of the binding material.

It was clearly important to consider a full consolidation treatment to improve the stability of the failing paint layer; it was therefore necessary to consider consolidants which would work sympathetically with matte paint, and be able to cohere very finely powdering paint. The application method would also be significant; a misting technique might be viable, but the very poor condition of the powdery pigment meant that too vigorous a mist could blast the uppermost paint layer off the surface, as well as pose a risk of marking the object. In addition, the painting could not be placed vertically even temporarily in case loose paint particles simply fell off. In the event it became clear that the flaking and powdery paint would have to be treated by different methods, as no single technique would ensure the stability of both; unfortunately it is outside the scope of this article to discuss both aspects of the consolidation treatment in detail.

Background to Funori

Summary of properties:

- works effectively at low concentrations;
- can be diluted with water;
- non-toxic;
- good penetrating ability;
- imparts no visible change to substrate;
- dries matte;
- resists acidity and microbiological attack;
- does not yellow significantly with ageing.

Alongside the SEM evidence of damage and other research, advice was sought from paintings conservators at National Galleries Scotland and paper conservators at the V&A. Altogether, the various researches indicated that funori would be worth considering as a possible consolidant for the powdery paint. Traditionally, funori has been used in Japan since the late 17th century as an adhesive and sizing material for textiles and paper (Chapman 1980 *in* Swider and Smith 2005), and as a result of this history has come to be used by paper, paintings and furniture conservators to consolidate paint, attach facing papers and make paper repairs. Funori has a unique chemical structure and qualities that are engineered by a combination of properties from two different sub-groups of seaweeds which are both classified under red seaweeds of the family Rhodophyta (Swider and Smith 2005). Various studies of the historic and conservation use of funori have concluded that its structure is probably the reason for its documented resistance to acidity and microbiological attack. Alongside more recent research, its historic use also provides good proof of other desirable ageing properties. As opposed to some protein consolidants, it does not appear to yellow with age (Thuer 2009), and whilst it will become slightly more brittle with ageing, it still retains good flexibility. Very much to advantage in the treatment of matte paint, it can be successfully used in low concentrations with comparably low surface tension and shine on drying.

Although there are many examples of the use of funori with furniture, paintings and paper artefacts, there is less to compare in the conservation literature with regard to textiles. One similar textile treatment was discovered, concerning an Indian painting on textile circa 1570 at the Freer Gallery of Art in Washington DC in 1977. The treatment consisted of painting a funori solution onto vulnerable white or pastel areas; a further application was necessary one month after the initial consolidation, but re-examination as recently as 2005 showed no further treatment was yet required.

It is worth noting that Lascaux produce a purified form of funori, known as JunFunori®. In many respects, it does exactly the same work of funori, but with the assurance of a purification process

to assure quality; the cost in 2010 was £51.50 per gram, however, and for this reason alone it was not a good option for an investigative process.

Preparation of Funori

In its unprepared state, funori is a brittle seaweed which is orangey brown in colour. There is a wide variety of examples of different weight/volume that might be used for stock solutions. One gramme of funori has been used with volumes of water from between 30ml to 300ml (Swider and Smith 2005) for different artefact types. For consistency and simplification, a 100:1 solution was selected which was adjusted to lower concentrations as required. Generally speaking, desirable attributes for consolidant solutions include a low concentration to assist penetration between the paint layer and substrate. Comparable penetration and solvent evaporation rates are also important, as this assists with even coverage and avoidance of over-application which can incur colour change and banding. Low concentrations also allow for gradual increases in overall strength, also preferable to blanket coverage at a higher strength in order to assess bonding progression.

To prepare a stock solution is straightforward but involves a few stages. First the funori is cut up into small pieces and soaked in water overnight; if desired, it can be rinsed thoroughly beforehand to flush out particulate material and salts. Once soaked the broken down funori is quite viscous and cloudy, with particles still clearly visible. It is then cooked over a low heat until it dissolves, after which it is strained at least once through a fine cloth to remove any larger insoluble parts. It will then keep for about one month when refrigerated.

The Jain painting tests comprised applying different concentrations of funori on 'powdery' paint samples made from historic cotton that had been sized with starch paste, burnished and painted with thick layers of gouache pigment mixed with a small amount of gum Arabic. The consolidated samples were then assessed for the subsequent effect on the paint medium, including bonding, visual appearance and handle, to determine the optimum strength for the Jain painting. After many tests a solution of 0.25% applied in 4 layers was arrived at.

Application Method

Equally as important to the success of the treatment as the right concentration was the application method. Brushing the solution on, either via facing papers or directly, was not possible due to the friable surface. Initially, attempts focused on the feasibility of using a medical nebuliser to apply the consolidant in a misting technique as it can produce fine mists with a very small particle size, which is highly suitable for penetrating between small particles of powdery paint. However, even with modifications to the nozzle to increase the mist flow and direct it down onto the substrate, the mist dispersed too freely and was actually too fine to be able to visibly determine when saturation of the paint layer was occurring, if at all. Consolidation of powdery paint will only be successful if the solution wicks through to the ground cloth (Michalski et al 1998.) It was also obvious that attempting to build up incremental layers of consolidant via a nebuliser was unrealistically slow.

The simplest solution to this problem was to move up to a larger device, namely the ultrasonic mister. Although it was necessary to remove the de-mineralisation cartridge to prevent blockages, no further modifications were required. Some issues are noted with this method, particularly that it is not generally seen as a good treatment for flaking paint because the low concentration required for successful misting is not sufficiently strong for larger flakes to adhere (Michalski et al 1998). Mist dispersal can also be an issue, but this was quickly resolved by the use of a plastic box to create a chamber. The box not only contained the mist well, but allowed the treatment to be

observed in progress; this was important because it transpired that the heavy soiling on the object was highly mobile, and monitoring was essential to avoid dirt streaking.

A different element to the testing process had concerned how to reduce the heavy particulate dirt in preparation for consolidation. It is sometimes useful to surface clean painted surfaces using a lightly dampened brush, since this can have the dual benefit of reducing soiling whilst reintroducing moisture. This in turn helps to reactivate any existing binder; however, there was some concern over how much powdery material might be unintentionally removed by this method. In order to quantify this risk, an SEM examination of a blotting paper sample which had had the paint residues from a dampened brush deposited onto it was carried out. The images were encouraging, and showed a very small number of paint residues had been removed through brushing. All were around 20 microns in diameter, and as the smallest fleck of paint visible to the naked eye measures several hundred microns, the indication was it would be acceptable to proceed with cleaning in this manner given the benefit of reducing the black dirt. A surprising amount of black soiling was removed in this way, especially as the brush strokes were limited to between 6-8 per surface area due to the mobility of the soiling.

The cleaning and consolidation treatments were carried out having first mapped out the object into sections on paper in order to work methodically through both processes. Having taken a long time to arrive at a suitable application method, concentration and quantity to apply, the actual treatment was straightforward and relatively quick. Each section was first humidified gradually to 80% RH using the clear box placed over the painting on glass blocks to create a semi-enclosed chamber. Both the cleaning and additional humidification just prior to treatment helped reactivate any existing binder, and encouraged absorption of the consolidant by the textile support without colour change or banding occurring. The 0.25% funori solution was misted continuously for 1½ minutes and then rested for 5 minutes, which allowed enough time for the vapour to absorb before receiving another consolidant layer. Even and consistent coverage is important as it reduces the possibility of future surface tensions, so the treatment was carried out using a timer at all times. Three further 'layers' of funori solution were misted on in the same way, allowing the consolidating medium to build up incrementally to achieve the necessary strength.

The additional consolidation of larger flakes was then carried out more painstakingly by hand, focusing on specific colours and areas of worst damage such as the lower border. Much of the previous research had focused on treating the powdery paint, but the earlier tests also indicated it might be useful to work with a different consolidant which has been used very successfully at NMS for the treatment of Thangka paintings. The consolidant used was Bermocoll, an ethyl hydroxyethyl cellulose which has good flow properties and can be diluted without losing too much strength.

Conclusion

The combined consolidation treatment appears to have worked effectively to stabilise the Jain painting and allow it to be displayed at a sloping vertical angle. It was however, felt to be too vulnerable to hang freely, as was probably originally intended, and so it is supported against a custom made padded board. Due to the angled display, the hanging is only attached with stitching from the unpainted top edge via a Velcro® webbing strip applied to the reverse ground turning. Although monitoring will play an important part in ensuring the hanging remains stable, it currently appears that the consolidation has been successful in all respects.

Acknowledgements

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Suppliers

Bermocoll E (ethyl hydroxyethyl cellulose)	Akzo Nobel Functional Chemicals AB, SE 444 85 Stenungsund Sweden Tel: +4630385000 E-mail address: Regulatory.AffairsSE@akzonobel.com
Funori (polysaccharide seaweed)	Kremer Pigments Inc. 247 West 29th Street New York NY 10001 Tel: (212) 219-2394. Fax (212) 219-2395. Kremerpigments.com

Lascaux Junfunori® (polysaccharide seaweed)	A P Fitzpatrick Fine Art Materials 142 Cambridge Heath Road Bethnal Green London E1 5QJ Tel: ++44 (0)20 7790 0884 Fax: ++44 (0)20 7790 0885 www.apfitzpatrick.co.uk.

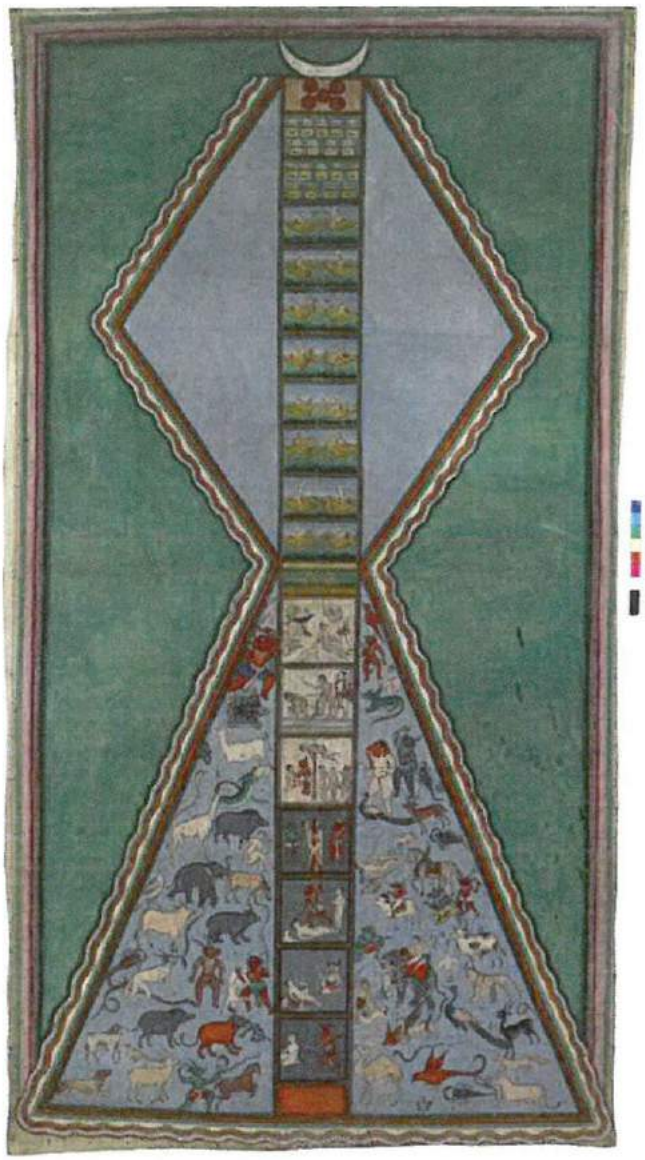

Figure 1
Overall view of the Jain Painting

Figure 2
Detail of dog in lower proper right showing extent of powdering paint.

Figure 3
Detail of man/monkey's head showing chunky, flaking

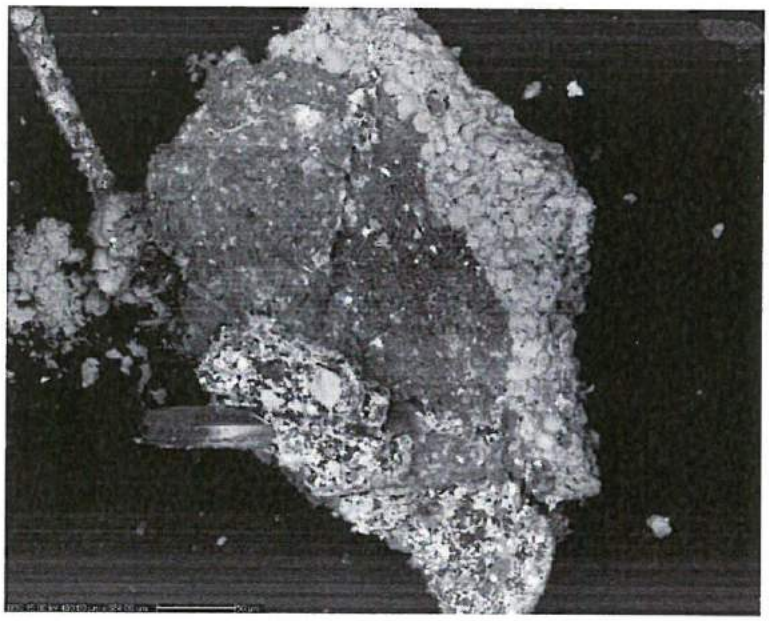

Figure 4
SEM micrograph of powdery paint particle x 250

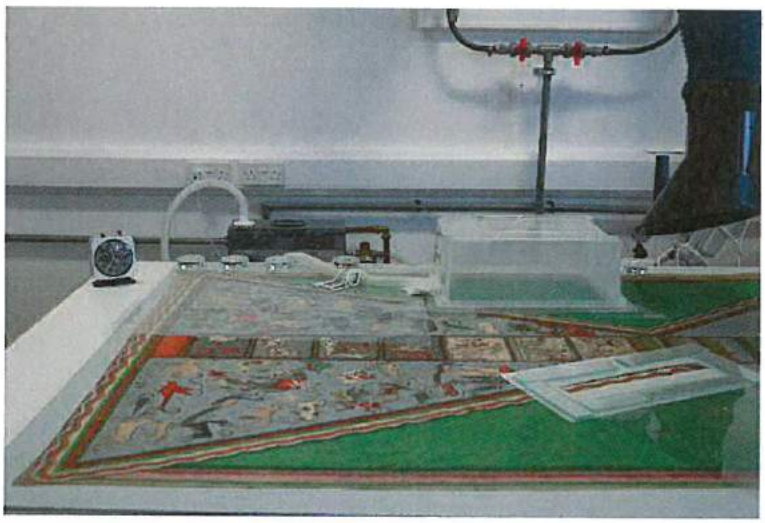

Figure 5
Consolidation of the Jain painting in progress

Conservation lining of a painted Jain textile from the Chester Beatty Library

Rachel Phelan
Rachel Phelan Textile Conservation, Dublin, Ireland

Introduction

The Chester Beatty Library, Dublin is an art museum and library which houses the great collection of manuscripts, miniature paintings, prints, drawings, rare books and some decorative arts assembled by Sir Alfred Chester Beatty (1875-1968). It has rich collections from countries across Asia, the Middle East, North Africa and Europe.

An American by birth, Chester Beatty made his fortune in mining, and having lived in London since 1912, he decided to retire to Ireland in 1950. An avid collector of illustrated maunscripts; he built a library in Shrewsbury road, Dublin, which opened in 1954. His collection was left in trust to the Irish nation on his death in 1969. In 2000 the Library moved to new premises in Dublin Castle.

While the collection consists principally of paper and books, it also includes a number of textiles. The subject of this paper is the conservation and display of a mid-19th century Indian painted textile, depicting a Jain Cosmology. The challenges faced by the media, size and condition of the piece together with the treatment carried out and rationale behind it are detailed. It should be noted that throughout textile conservation terminology has been used, as opposed to that of paper conservation.

Jain Cosmology

Jainism is an ancient Indian religion and based around the belief that the universe is divided into three worlds; the upper or celestial realm, the middle, mortal world and the lower world of the dammed. The most important of these worlds is the *Maushyaloka* or middle world of mortals, as it is here that one can attain enlightenment and freedom from the cycle of rebirth.

The Chester Beatty Cosmology (InE 1669) depicts this middle world in schematic form with the sacred Mount Meru at the centre surrounded by concentric rings of continents and oceans filled with aquatic animals. This circular representation is set into ornate floral corners and borders so that the whole design forms a square.

Construction

The object is 90cm square and consists of layers of polychrome opaque watercolour and gold leaf, painted onto lightweight, tabby weave, cream cotton. About 5mm of fabric at the borders is unpainted. It was designed to be a portable devotional object, rolled and unrolled as necessary.

Condition

The object was in a very poor condition. It had surface and ingrained soiling and was distorted throughout due to the method of manufacture, use, rolled and folded storage. There were previous repair patches visible through multiple areas of loss in the ground fabric. The fabric itself was very

weak and abraded with many small structural splits throughout. The corners were bent over with several pierced holes through them, due to previous mounting. One corner section was missing and had been replaced by a paper patch repair. The painted surface was abraded with extensive pigment loss, revealing a fine chalky ground underneath. In numerous areas both the paint and gold leaf were flaking and lifting from the ground fabric. In some places the layers of different paints and gold had de-laminated in horizontal cross-sections, one on top of the other.

Treatment Methodology

The textile conservator was first invited to examine this object, with the intention of conserving it for exhibition display at the Chester Beatty Library in 2006. Following extensive examination and consultation with conservation and curatorial staff, it was agreed that at that time it was not possible to devise a safe and suitable way in which to display it; that would allow for the consolidation of all elements of the piece, whilst maintaining the structural integrity and flexible nature of the object.

It was agreed that the textile conservator would continue to explore treatment options and contact the Library should further developments came to light. In 2008 the textile conservator was invited to attend a three-day master class on Thangka conservation at the National Museum of Ireland, given by Mike Wheeler (Senior Paper Conservator, V&A) and Theresa Heady (Senior Objects Conservator, St. Paul's Cathedral). Following this practical training course the textile conservator realised how specific techniques might be adapted for the Jain textile. This resulted in a new treatment plan being developed and agreed with the Library's book and paper conservation staff, Jessica Baldwin (Head of Conservation) and Rachael Smith (Paper Conservator). All work was carried out in the Chester Beatty conservation facilities.

Initial Treatment and Consolidation

Due to the extremely fragile state of the flaking and lifting paint and gold leaf, a decision was taken to consolidate these elements first, before further treatment and examination of the object was carried out. Accordingly only the obverse of the textile was photographed and documented and no surface cleaning was carried out as this would have resulted in the removal of large elements of the painted design.

After tests, it was decided to consolidate the flaking areas of paint with a 0.5% solution of Bermocoll® E230 (ethyl hydroxyethyl cellulose), using a medical nebuliser. This technique disperses the adhesive solution into a fine mist and allowed for large areas of the lifting paint and gold to be consolidated without physically disturbing the surface. The solution was applied three times over the whole obverse by the paper conservator. As necessary, further consolidation to large flakes was carried out by localised application of a 2% Bermocoll® solution with a fine brush applied directly to lifting paint. A few drops of alcohol were added to the solution in order to aid penetration of the adhesive.

Once the image was stabilised, the object was turned and the reverse examined and documented. It had very heavy surface and ingrained soiling with a multiplicity of paper patches. Many of these patches had split and failed. They were often layered on top of each other and created multiple tensions while providing insufficient support to the textile ground fabric. They would appear to have been applied haphazardly, over time; with whatever material came to hand, in one case European script was visible on a patch.

After tests the patches were moistened from the reverse by the paper conservator with a 1% methyl cellulose (Methocel® MC 64620) solution and mechanically removed. The whole reverse

was then swab cleaned by the textile conservator with de-ionised water to remove soiling and reduce adhesive residue. This greatly improved the visual appearance of the reverse and prepared for further treatment. The paper conservator then supported fragile areas of tearing and loss in the ground fabric using Japanese tissue bridging repairs; applied with a dilute wheat starch paste solution, in order to realign the tears and secure these sections in place.

Lining

Due to the overall structural weakness of the object, it was decided to give it a full lining, using Japanese paper. In preparation for this, the textile was humidified using a 'sandwich' of Sympatex® (breathable membrane hydrophilic polyether-ester copolymer) and damp cotton to relax the weave. When tested all the paint pigments were fugitive in water, consequently it was important to achieve uniformity of moisture throughout the object to prevent colour transference.

As the piece was humidifying (over approximately three hours), the lining papers were prepared. A medium weight Japanese kozo paper was selected due to its inherent strength, flexibility and long fibres. The size of the textile meant that two large sheets were needed for the lining. The paper was measured and wet torn to ensure long fibrous edges that would matt together on application. A wheat starch paste was also prepared and diluted down to the consistency of thin cream. The lining paper was then placed onto a sheet of Melinex® (polyester film) and pasted out.

The humidified object was removed from the 'sandwich' and placed face down onto a sheet of Bondina® (non-woven polyester). The pasted paper, cast onto Melinex® was lowered onto the object. A good bond was secured by tamping over the surface with a stiff Japanese *Narebake* brush before removing the Melinex®. The second sheet of paper was applied in the same manner. The two sheets overlapped by about 3cm and the position of the overlap was offset so that it did not run along the centre of the object, an area that has been structurally weakened by folding. The papers extended beyond the edge of the object by 5cm on all sides.

Pasted border strips 10cm wide were applied to the edges and tamped down. They overlap the textile by about 2cm. These border strips are designed to strengthen the edges of the object and allow the lined textile to be evenly supported when placed under tension.

The textile was then lifted, turned face up and placed onto polyester felts and the Bondina® sheet peeled back. No pigment transference occurred. The object was left to air dry overnight on the felts, so that the papers and textile became consolidated together as one. No weighting was carried out and cockling and distortions were allowed to occur naturally during the drying process.

Tensioning Out

The following day the piece was re-examined to ensure that the lining was fully adhered. The textile was then re-humidified as before. It was placed face up onto a large board of 3-inch marine ply (waterproof composite plywood), which provided a practical alternative to a large Japanese karibari drying board. The edges of the border strips were folded back against a Melinex® barrier strip, pasted with a more concentrated wheat starch paste solution (double cream consistency) and then adhered to the board. The object was covered in clear plastic sheeting to slow down the rate of drying and left for twenty four hours. The plastic was then removed and the textile was left to dry under tension on the board for five weeks.

While the piece was on the board, areas of loss to the cotton ground were in-filled to reduce their visual impact. The paper conservator selected a medium weight Japanese paper. Initially the papers were toned with watercolour to correctly match the original colour of the missing sections, however it was found that by tinting the infills to match the neutral shade of the unpainted border, they were far less visually obtrusive. This also allows areas of loss to be easily identified by the observant viewer. The paper infills were adhered into position with a dilute wheat starch paste.

Mounting

The lined object was removed from the marine ply board and the paper trimmed back. A decision was made to mount the piece as a textile, though it would have been possible to hinge mount it, as is common practice in paper conservation. It was agreed that by completely stitching all four edges, a uniform tension could be applied, preventing any further movement while on display.

A large fabric covered board was prepared from corriboard (polyester corrugated sheeting) covered in polyester needle felt and Baumann Ultra cotton No.123. The painting was stitch-mounted onto the padded board through the paper support into the unpainted fabric edge using Skala (polyester monofilament) thread. The mounted textile was framed with a rebate to conservation standards and is now on display in the Sacred Traditions Gallery of the Chester Beatty Library, Dublin.

Conclusion

Conservation of mixed media objects presents particular challenges in order to ensure that all elements are respected. By collaborating with conservators of different disciplines a treatment plan was developed that has allowed the object to be made structurally sound while still retaining the flexibility of a textile. There was no disturbance of the many fugitive pigments whilst using this methodology. With the exception of the nebuliser, minimal equipment and materials were required to treat the piece. By casting the lining papers onto Melinex, they could be more easily handled by conservators unused to working with large adhesive paper linings.

The development and implementation of this project has provided a unique opportunity for the exchange of knowledge, skills and terminology between two different specialities. Drawing on the strengths and expertise of each conservator allowed a direct exchange of practical experience and a wider appreciation of disciplines used to working side by side, but not together.

Acknowledgements

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Suppliers

All suppliers in Ireland unless otherwise stated.

Baumann fabric	Form and Line Ltd. 63 Lower Beechwood Avenue Ranelagh Dublin 6
Corriboard	Access Plastics Ltd. Access House Unit 16 Ashbourne Co. Meath
Marine plywood	Woodworkers Ltd. 1-10 Mount Tallant Avenue Terenure Dublin 6W
Medical nebulisers	www.nebuliser.ie
Skala thread	Woollen Mills, 41 Lower Ormand Quay, Dublin 1
Sympatex®, Bondina®, Melinex® Methyl cellulose Polyester needle felt Wheat starch paste	Preservation Equipment Ltd Vinces Rd, Diss, Norfolk IP22 4HQ
Japanese Paper	John Purcell Paper 15 Rumsey Road London SW9 0TR
Bermocoll® E230	Akzo Nobel Functional Chemicals AB Cellulosic Specialties SE-444 85 Stenungsund Sweden

Figure 1
Obverse before conservation.

Figure 2
Delaminating paint and gold leaf - detail.

Figure 3
Paper patch at corner - detail.

Figure 4
Consolidation with nebuliser.

Figure 5
Reverse before conservation.

Figure 6
Before and after patch removal and cleaning - detail.

Figure 7
Casting prepared paper to reverse.

Figure 8
Laying down border strips.

Figure 9
Peeling back Bondina after lining.

Figure 10
Pasting edges of border to board.

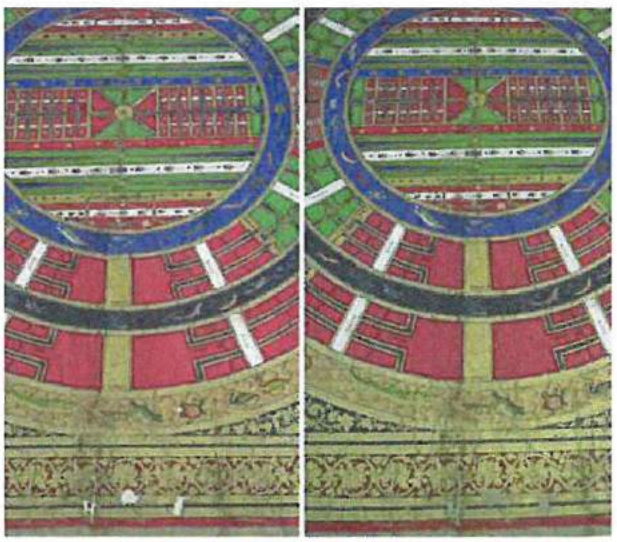

Figure 11
Before and after paper infills - detail.

Figure 12
Mounted on padded board for framing.

To catch an emerald thief: an investigation of pigments using scientific analysis to determine the cause of substrate loss in painted textiles from Rajasthan.

Jane Wild
Textile Conservator, National Gallery of Australia

Introduction

The National Gallery of Australia (NGA) acquired the first painted shrine hanging or pichhavai from Rajasthan in 1989. The NGA currently houses 15 painted and five embroidered pichhavai, a significant holding of what are considered to be unique and culturally significant examples of Hindu art. The pichhavai have received a great deal of public interest becoming a much-loved feature in the permanent galleries dedicated to the exhibition of textiles, paintings and sculpture from India.

Conservation of these large format painted textiles is challenging. As items of utility, pichhavai have deteriorated from a lifetime of wear and worship, which accounts for their mostly fragile condition. Many pichhavai are stained with crude repairs and significant pigment and substrate loss, and although the condition of each pichhavai varies, some similarities have been noticed in relation to substrate loss associated with a green pigment.

A literature review of the conservation treatment of pichhavai revealed that unlike Indian miniatures, little information pertaining to treatment or analysis has been recorded. In an attempt to understand the nature of the substrate loss, identify the cause of the deterioration and make informed decisions regarding conservation treatments, a thorough investigation of the pigments became necessary.

This paper focuses on a pichhavai entitled 'Krishna's fluting summons the entranced gopis' (Figure 1). The image depicts Krishna surrounded by 129 gopis or milkmaids. All the women are portrayed elaborately adorned with jewellery, encrusted with rubies and emeralds. The mystery lies with the missing emeralds. The small but numerous areas which once depicted emeralds are missing, with complete loss of the underlying cotton substrate. Each earring exhibited varying degrees of loss however two small areas of green remained in tact, the evidence conservators needed to determine which pigment was responsible for the fibre loss (Figure 2). Analysis was required to help determine which pigment was responsible for the localised substrate loss.

The pichhavai painting tradition

In the sixteenth century the Mughal empire prospered under Akbar (1541-1605) who unified the state by embracing both Muslim and Hindu values. Persian-Islamic and Jain-Hindu artists worked together to paint Indian miniatures creating a successful fusion of the two artistic styles. The imperial painting studio thrived under Akbar's successors until the eighteenth century when the empire began to decline under the rule of Aurangzeb (1618-1707). Aurangzeb took a fundamentalist interpretation of Islam shunning dancing, music, singing and painting. Hindus were persecuted and the nation was in a constant state of war. The rapid decline of painting at the royal court saw the once gainfully employed Hindu craftsmen dispersed throughout northern India. In the Mewar region of southern Rajasthan painting schools emerged in Jaipur, Kota, Udaipur, Jodhpur and Nathadwara. The artists were no longer restricted in their subject matter and were free to

draw inspiration from Hindu traditions. It was at this time pichhavai painting developed (Lazaro 2005:21).

The art of pichhavai painting

pichhavai originate from the northern Indian state of Rajasthan. pichhavai are used to decorate Hindu shrines and have been incorporated into daily worship as they can be hung and changed regularly and stored away easily after use. The pichhavai hang at the back of the shrine behind the deity and vary in scale (up to three metres square) depending on the size of the shrine.

Traditional pichhavai painting has its foundation in Indian miniature painting where similar techniques have been passed from master to student for more than 400 years. Over the last two hundred years pichhavai painting techniques and materials have remained largely unchanged amongst the various schools and families throughout Rajasthan. Painters begin as an apprentice and train for many decades to become a master. The artist embarks on a spiritual journey and a life-time devoted to worship, love and contemplation.

Traditional pichhavai painting is a detailed, time-consuming procedure with each work taking months or often years to complete. The process begins with the apprentice who has the arduous task of preparing the pigments. For hundreds of years in India, pigments have been prepared from various natural origins both organic and inorganic.

Pigments are soaked, washed, filtered through cloth, dried in the sun and hand-ground until a fine consistent powder is produced; a process which can take weeks. When the pigments for painting are required the powder is often mixed in a mussel shell with a little water and gum arabic to exact proportions (Lazaro 2005: 92).

The image is traced onto the cloth using an elaborate grid of geometric lines based on the principles of sacred geometry. Painting begins with the base colours and the design is built up. Between each application of paint, the surface is burnished or polished with a smooth stone typically an agate; this intensifies the colours giving them a satin-like sheen. Lastly, the gold paint or leaf is applied and the finishing fine-line detail is added (Lazaro 2005: 65-108).

With years of spiritual and technical training ahead for the young painters and an ever growing interest in pichhavai painting from around the world, it is easy to see why many untrained painters are substituting natural pigments with synthetic poster paints, sacred geometry with a stencil, and replacing spiritual enlightenment with a financial aspiration. Today's changing India is moving away from 'traditional standards' toward commercialism, which is having a direct impact on the master-pupil relationship. This relationship is pivotal to the pichhavai painting tradition. Without it knowledge and skills cannot be taught to the next generation and traditional techniques are in danger of disappearing entirely (Lazaro 2005: 10).

Present Condition and Factors in Deterioration

Several pichhavai have been conserved in preparation for display in the permanent Indian galleries at the NGA. During examination, analysis was undertaken to determine what materials were used in the construction of these pichhavai.

Analysis was undertaken using a Scanning Electron Microscope (SEM) with Energy Disperse X-ray (EDX) attachment coupled with visual analysis using an Olympus BX60 polarized light microscope. Pigments were identified on several pichhavai to establish a database of the materials used whilst

determining whether pigments were dangerous or toxic. Many of the pichhavai have large amounts of loosely bound pigment making it important to establish which textiles would require extra health and safety precautions when handling them. Some of the toxic pigments found were cuprous copper arsenite (emerald green), arsenic sulphide (orpiment), mercury sulphide (cinnabar) and various lead and copper compounds.

Many of the pichhavai in the collection exhibit two types of loss; loss of pigment and loss of substrate, both leading to loss of the image. The loss can be attributed to either chemical or physical factors or both in combination. Cellulose degradation of the cotton can weaken the substrate fibres, making the cotton more susceptible to the physical damages associated with display and handling, when pichhavai were constantly rolled and unrolled for display. This cycle of display and storage in an uncontrolled environment has resulted in tears and weakened areas of cloth, with the majority of paint loss, staining and damage in the lower third section. Mould growth, insect and animal damage have caused staining and in several areas, subsequent fibre loss.

Chemical deterioration has been caused by unstable pigments which have, over time, corroded the underlying substrate fibres. Research and analysis has been undertaken to determine which pigments are responsible for substrate charring and areas of complete fibre loss. Comparison of the condition of various pichhavai reveals a pattern in their deterioration which indicates that the substrate loss is directly associated with the green pigment used specifically in the imagery to represent emeralds.

Scientific investigation concentrated on 'Krishna's fluting summons the entranced gopis as previously noted.

Pigment analysis and sample methodology

Two sets of pigment samples were taken from 25 areas and included a variety of colours visible throughout the image. One set of samples were placed on a slide, dispersed in water and mounted in Cargill Melt Mount, refractive index 1.66. The mounted samples were examined at x200 and x400 magnification using an Olympus BX60 polarizing microscope. Polarized light microscopy enables the pigment samples to be identified visually utilizing each pigment's unique morphology, reflectance and colour. However interpretation of results and conclusive identification relies on a skilled and practiced eye.

A second set of samples were prepared on aluminium stubs with a carbon paper coating. EDX enables elemental analysis of samples which offers both qualitative and to a lesser extent quantitive results. A high-energy electron beam hits a sample and the X-rays characteristic of the atoms in the specimen are generated within the region. The energy of the X-rays (or equivalently their wavelength) indicates qualitatively which elements are present in the sample under investigation. Measuring the X-ray intensities indicates roughly how much of each element is present. Identifying the elements present in each sample indicates a molecular structure which signifies the presence of certain pigments.

Results of analysis

Utilising the two analytical techniques a broad range of pigments was identified. David Wise, Senior Paintings Conservator at the NGA analysed the first set of samples using polarized light microscopy. Red lead, Indian yellow, gamboge, carbon black, chalk, lead white, cinnabar, indigo and metal foil were identified in the samples. The results indicate that various pigments were mixed to achieve reds, blues, greens, yellows and their various hues.

Of particular interest were green pigments, more specifically the green pigment responsible for the uniform areas of substrate loss. Samples of a variety of greens were collected from the forest foliage and the gopis garments, as well as, the main focus of the investigation, the missing emerald jewellery. Sampling the pigment responsible for the substrate loss proved difficult as very few areas remained. Of the 129 gopis only two small sections of light green earring remained intact.

The green samples taken from the jungle foliage and gopis garments were found to be a mix of indigo, terre verte, gamboge, lead white and chalk. A positive identification for a copper based pigment was found in the sample associated with the substrate loss, but the visual identification was inconclusive.

The results from the EDX confirmed the presence of many of the elements associated with the pigments identified using the polarized light microscope. One interesting addition was arsenic which indicates the presence of Orpiment As_3S_3, used specifically to paint the gopis' yellow makeup. Gold, tin and silver were all identified as the elements found in the various metal foils.

Samples taken from the light green foliage, an area where the pigment appears stable revealed the presence of lead, magnesium, silicates, potassium and aluminum. Given these elements, it is possible that the foliage was a mixture of the inorganic mineral pigment terra verte $K[Al,Fe^{III}),(Fe^{II},Mg)](AlSi_3, Si_3, Si_4)\ O_{10}\ (OH)_2$, lead white $PbCO_3$ and gamboge $R_1=(CH_2)_2C=CH(CH2)_2,R_2=CO_2H,R_3=CH_3$ an organic plant material (Figure 3).

In the sample taken from the darker green used to outline the earrings the results indicate the presence of gold (Au), lead (Pb), silicates (Si), potassium (K), aluminium (Al), iron (Fe) with the addition of copper (Cu). The presence of these elements indicates that it is possible the following pigments were present in the sample; gold foil (Au), terra verte, verdigris $Cu(CH_3COO)_2$ or malachite $CuCo_3$ and lead white (Figure 4).

Minute pigment and fibre samples were taken from the areas neighbouring the substrate loss. The results of the elemental analysis proved similar to the dark green earring sample; however here the quantity of copper (Cu) increases significantly. These results imply strongly that the substrate fibre loss is associated with the presence of copper (Figure 5).

Evaluation of the Results

There are a variety of greens used in the traditional pichhavai artists' pallet. The findings indicate the palette itself is extensive and includes many pigments mixed together to achieve certain colours. It appears that different pigments were also used for specific purposes. Orpiment appears isolated to the gopis makeup. A copper based pigment has been used to create the green earrings but is absent in other areas of green such as the foliage.

Wheeler noted a similar occurrence when analysing the pigment pallet of a large format Mughal manuscript painted on cloth, dating back to the late sixteen century. Analysis of pigments revealed indigo, azurite, red lead, vermilion, orpiment, verdigris, lead white and carbon black, a strikingly similar line up to the pallet used to paint the significantly younger pichhavai (Wheeler 2007:22-29).

Traditionally malachite (*danapharang*), verdigris (*zangal*) terreverte (*harabhata*) and emerald green (*selu*) are the most common green pigments used in Indian miniature painting (Gupta, 2006: 18) and are regularly found in pichhavai painting. Many greens were achieved by mixing indigo (*neel*), Prussian blue, orpiment (*harital*) Indian yellow (*goguli*) and gamboge (*gemboge*). Landscapes were

often painted with a mix of greens, a practice associated with the Kota, Bundi school Kishangarh and Baholi schools (Lazaro 2005: 172).

Green Pigments

There are several pigments that contain the elements present in the samples associated with the substrate loss. The first is terre verte also known as green earth, a complex composition of minerals comprising glauconite and celadonite. These minerals are hydrous potassium silicates of iron, magnesium, and aluminium, crushed and finely ground for use as a pigment. Being a natural earth pigment it is found in different shades ranging from yellowish green to pale greenish grey. Terre verte is a very stable pigment and is unaffected by light, air, dilute acids, alkalis (Gupta, 2006: 38) and can therefore be ruled out as a suspect of fibre corrosion.

Both analytical techniques identified the presence of copper in the sample associated with fibre loss. There are many green pigments that contain copper. Brunswick green $Cu_2(OH)_3Cl$ (not documented for its use in Indian miniature or pichhavai painting), a basic copper chloride made from copper filings and ammonium chloride, and two members of the copper arsenite group; Scheele's green $CuHAsO_3$ and emerald green $Cu(CH_3COO)_2.3Cu(AsO_2)_2$ (Scott 2002: 310). The two later pigments were eliminated based on the absence of arsenic in the samples and the former as its use in pichhavai painting has not been documented.

Two pigments containing copper that are well documented in both Indian miniature and traditional pichhavai painting, are malachite and verdigris. Malachite $CuCO_3.Cu(OH)_2$ is a carbonate of copper found in copper ore. The semi precious stone is ground, washed and strained; a process which remains largely unchanged in thousands of years (Scott 2002: 300). Malachite is a carbonate decomposed by acids, but unaffected by light, resulting in the pigment going unchanged in many paintings over the centuries (Gettens and Stout 1966: 27). Although malachite is a beautiful permanent pigment it has little covering power and therefore has not been used extensively in Indian miniature painting (Gupta 2006: 18).

Verdigris $Cu(CH_3COO)_2.2Cu(OH)_2$ is one of several copper acetates. Copper acetates can be broken into two main groups: basic copper (II) acetates and the more unstable neutral copper or copper (I) acetate. Essentially the pigment is a corrosion product produced from copper or copper alloys exposed to organic acids. Verdigris ranges in colour from pale blue through turquoise to green. The properties of this pigment may vary depending on the organic materials used in production. Accounts of pigment preparation date back to the first century and through the ages various organic materials such as stale vinegar, distilled wine, sour milk and even urine have been used (Scott 2002: 271).

Verdigris is the most reactive and unstable of copper pigments, adversely affected by environmental factors particularly high humidity. Prolonged contact with moisture causes it to break down into cuprite and acetic acid which in turn causes charring and weakening of the cellulose supports. The destructive effect of verdigris on the underlying cellulose substrate is well documented with the acetic acid charring and ultimately destroying the cloth, paper or parchment resulting in complete substrate loss (Gupta 2006: 19). Similarly free acids produced during the aging of iron gall ink cause charring of paper substrates. In Indian miniature painting the adhesive used as a medium for gold powder or for fixing gold leaf has been found to produce a similar effect (Gupta 2006: 38). The instability of verdigris has been known for centuries. Leonardo da Vinci (1452-1519) remarks that verdigris ground in oil can only last when varnished immediately after it has dried, otherwise "*it not only fades, but may be removed by a wet sponge, especially in humid weather. This is because of its saline nature; it becomes deliquescent in a moist atmosphere*" (Scott 2002: 293). Cases where the pigment has etched the substrate have also been recorded in illuminated manuscripts

where the pigment has eaten through the parchment leaving holes on the page in the areas painted with verdigris (Gettens & Stout 1966: 171).

The poor aging properties and instability of verdigris has been addressed in a variety of ways. To reduce darkening the pigment may be embedded in oil or oil-resin varnish to prevent it coming in to contact with moisture. Verdigris has been mixed with saffron to retard corrosion on sixteenth century to nineteen-century Persian and Indian miniatures (Eastaugh et al. 2004: 385).

Conclusion

The results of both analytical techniques indicate that the previously unknown green pigment associated with the specific and regular corrosion of the cellulose substrate associated has a copper content. The absence of arsenic automatically eliminates several copper arsenite pigments from the list of possible suspects. A literature review of pigments routinely used in Indian miniature and pichhavai painting indicates that verdigris, an acetate of copper, is a notoriously unstable pigment. Verdigris, unless isolated from the atmosphere in an oil or resin, decomposes in a humid environment to produce acetic acid which in turn corrodes underlying cellulose fibres thus removing both support and paint. This paper postulates that verdigris is indeed responsible for the specific fibre loss on numerous pichhavai in the NGA collection. The evidence supports verdigris as the self-destructive culprit responsible for removing those areas the artist has painted green to represent the gopis emerald jewels in 'Krishna's fluting summons the entranced gopis'. Has the elusive emerald thief been apprehended? We believe so.

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Figure 1
'Krishna's fluting summons the entranced gopis'.

Figure 2
Detail of image showing Gopis jewellery with missing emeralds and associated substrate loss.

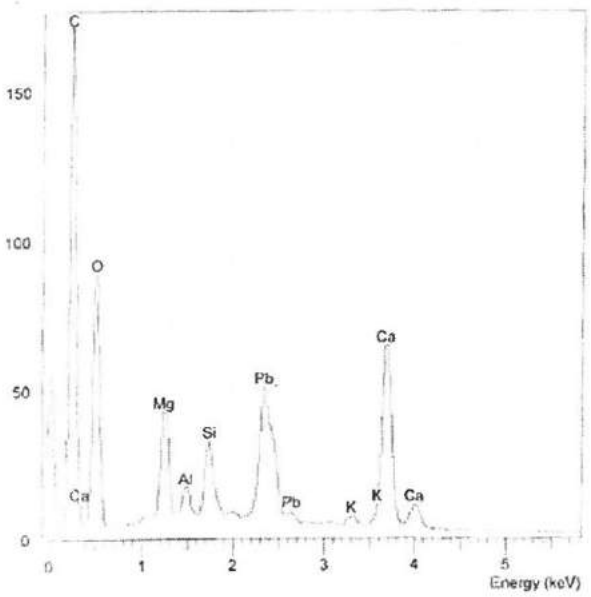

Figure 3
EDX results sampled from the stable area of light green foliage.

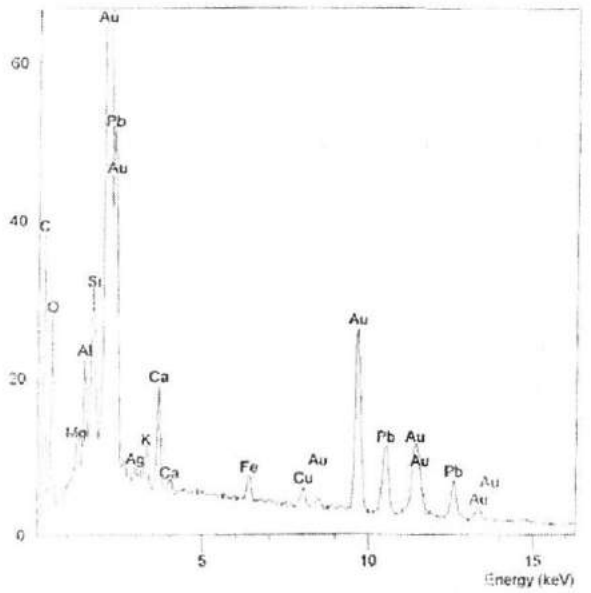

Figure 4
EDX results sampled from dark green around earring showing the presence of copper.

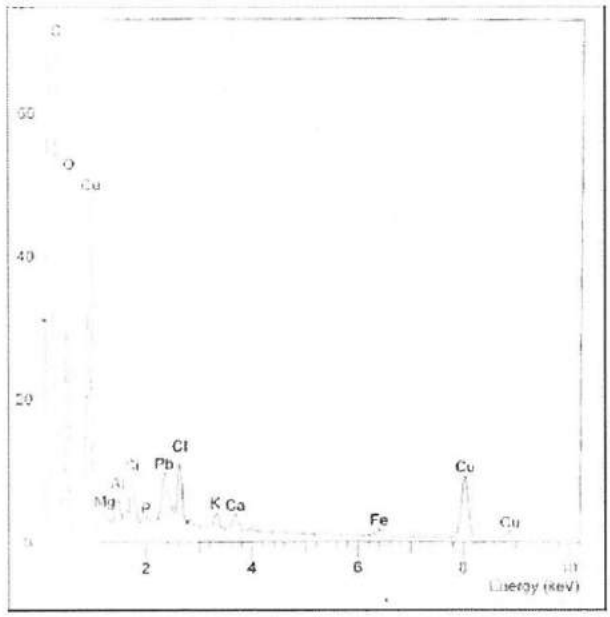

Figure 5
EDX results sampled from green earring showing the increased presence of copper.

Presenting rough and smooth with innovative technology

Dinah Eastop *PhD, MA, FIIC, ACR.*
Research Fellow, The National Archives, Kew (2010 – 2012); Honorary Lecturer, Institute of Archaeology, UCL; Honorary Research Fellow, Universities of Glasgow and Southampton

Introduction

This paper considers ways to enhance public access to 'textile sample books' while not adversely affecting their long-term preservation. It demonstrates three possibilities provided by recent digital technologies for the online delivery of museum and archive collections. Such delivery could form part of preservation strategies for textiles and related material, by providing online surrogates that could widen access while reducing handling of collections.

The Board of Trade Design Register

The 'sample books' discussed here are part of the Board of Trade Design Register, initiated in 1839 to protect the proprietors of original, ornamental designs from commercial piracy by allowing the proprietors to exert copyright over the designs they registered (Prouty 1957; Smith 1928). The National Archives in Kew, London holds the surviving Register: The Board of Trade *Representations and Registers of Designs, 1839-1991*. The Design Register takes the form of 11,122 items (either bound volumes with designs adhered to the pages or boxes of folders containing loose designs). The collection is arranged in six series, with each series associated with a particular act of parliament: the initial Design Copyright Act of 1839 and the subsequent Acts of 1842, 1843, 1850, 1883 and 1907 (Eastop 2011-2012). There are nearly 3 million designs, for a wide range of materials and products: metal, wood, glass, earthenware, paper hangings (i.e. wallpaper), carpets, printed shawls, other shawls (i.e. woven shawls), yarn, printed fabrics, other fabrics and lace (very broadly defined).

The Design Register is made up of two main types of record: *Registers* containing the text record of each design (the registration) and volumes or folders containing the *Representations* of the registered designs. Registers record the 'unique' number assigned to the design, the date of registration, the parcel number, the name of the design's proprietor and the proprietor's address. *Representations* of the registered designs take many forms, e.g. drawings, tracings, photographs, samples of cloth or other materials (e.g. crepe paper, straw), and complete artefacts, e.g. printed kerchiefs, straw bonnets, knitted socks and mittens (Figures 1 and 2). Each *representation* is labelled with its 'unique' design number. The Registers contain the majority of the information in written form but there is some additional text information on or alongside the representations. Examples include details of agents who sought registration on behalf of proprietors, the names of persons or places depicted in some designs (e.g. monarchs, buildings and battle scenes) and the numbers allocated to the designs prior to submission to the Design Register (e.g. studio design numbers).

Its excellent provenance, combined with the 'as new' condition of some representations (notably the textiles), means the Design Register has huge potential as a resource for historians of textiles, dress and design, of production, commerce and copyright, as well as for artists and designers. The Design Register has been used as a primary source by a range of scholars, e.g. for the study of shawls (Clabburn and Alfrey 1995; Reilly 1996); textile design, production and innovation (Greysmith 1983; Kramer 2007; Sykas 2005); innovation in the design and production of clothing (Levitt 1986; Rose 2007, 2010); and the work of the designer Christopher Dresser (Lyons 2005, 2007).

For further information on the Design Register see: http://www.nationalarchives.gov.uk/records/research-guides/reg-design-trademark.htm

For The National Archives' online exhibition of 300 Victorian ceramic designs from the BT Design Register see: http://www.nationalarchives.gov.uk/designregisters/

Preservation and Access

The core business of the Collection Care Department (CCD) at The National Archives is preservation and access, i.e. the goal is to optimise the long-term preservation of the records and to support public access to the records for a range of users. The latter include historians of all sorts (design, business and family) as well as artists and designers seeking inspiration in the designs, materials and techniques of the *representations*, and the curious juxtapositions of designs and products resulting from the registration process.

The Design Register is challenging in terms of both preservation and access because of the volumes' huge size and vulnerability, and difficulty in identifying its content because it has a complex organization. The *Registers* take two main forms: the earlier registers are bound volumes with many or several registrations per page; the later registers are smaller in size and take the form of binders containing typed registration sheets, one for each design. Most of the registers are easy to handle and the bindings still function well. In contrast, the volumes containing many of the *representations* are often large, heavy (26kg) and unwieldy, and some have weak bindings. The *representations* themselves vary in condition; some are vulnerable due to their materials and size. For example, unfolding the larger *representations*, folded to fit into the volumes, can be difficult, and many of the transparent papers are brittle.

Enhancing online access is an objective as it would provide one means of access for a range of users, and may reduce the number of speculative requests to examine the volumes themselves. The National Archives has extensive experience of providing online access to text records, via online delivery of scanned documents and via the online records of documents which have been transcribed and catalogued (to enhance searching), sometimes supplemented with metadata (additional information) (Bülow and Ahmon 2011). The long-term objective is to enhance the online resources for the registers with series BT44 (dating to 1842-1884) identified as a priority (with work in progress in 2012).

In contrast to the written record, making the designs available online is a philosophical and technical challenge. Identifying the diverse needs of existing and potential users was considered essential (Eastop et al 2012). Consultation events held in 2011, helped to identify character-defining features (e.g. texture) as an important feature to capture and deliver online. It was also clear that standard documentary images, presented in sequence, did not convey the visual and material excitement of the *representations*. Therefore alternative solutions were sought and explored for capturing key features of the representations and presenting them via digital surrogates. The three techniques investigated were: intuitive image browsing, polynomial texture mapping and haptic technologies.

Three innovative digital technologies

Consultation with existing and potential users suggested that standard digital photography would not meet all needs, so alternative imaging technology was investigated. Intuitive image browsing was identified as a useful, designer-friendly, exploratory tool for online access. Polynomial texture mapping (PTM) was shown to produce attractive, user-friendly results for examining textiles, basketry and wax seals. Haptic technology was also explored.

Exploring and sorting designs: Intuitive Image Browsing

As noted above, consultation with existing users and potential users of the Design Register demonstrated that rows of thumbnails or bigger images shown in linear sequence, were not found to be attractive or useful. For this reason, alternatives were explored, e.g. the possibility of online delivery of images of the designs via 'intuitive image browsing'. This image exploration approach was developed by a team at the University of Dundee working with the Liberty Archive (Ward *et al.* 2008). The research team recognised both the creative and commercial importance of image archives and the challenges of identifying and navigating their often vast content. Their approach was to consider how designers might want to use images and to recognise that humans "*are uniquely designed to process a tremendous amount of visual information*" (Ward et al 2008: 1). Gill (2012) has explored this capacity in her work on image-based documentation of conservation interventions.

Ward *et al.* sought to ensure that designers could navigate a set of images in a way that was meaningful to them. They developed 'intuitive image browsing' which allows many images (say 160) to be viewed on a single screen, and then sorted and reordered, much as you would do with coloured swatches on a table: spreading out the swatches, scanning them all, grouping the ones that meet your criteria, moving the others out of view, and focusing on those selected. Intuitive image browsing has been applied experimentally at the V&A. On the museum's test site, selections of different types of objects from the V&A collection can be viewed: http://collections.vam.ac.uk/information/information_fabricvisualiser

The system's developer explained that two helper windows can be switched on: The Navigator allows you to move round the image once zoomed in; The Magnifier shows the current object at a larger size. The controls are at the right hand side of the window. It works best with modern compliant browsers, such as Chrome, Safari, Firefox and recent versions of Internet Explorer. If you cannot follow the link back to the V&A catalogue it could be because a pop-up blocker is enabled or the V&A is not running the service that enables the link at that time.

Capturing and exploring texture: Polynomial Texture Mapping (PTM)

Texture was identified as an important feature of some *representations*, notably of woven textiles, lace and straw-work. For this reason image capture techniques which allowed the capture and representation of texture were sought. Polynomial Texture Mapping (PTM) was identified as a possible technique. PTM, one application of Reflectance Transformation Imaging (RTI), which captures the reflectance characteristics of surfaces, is an image capture and processing technique developed by HP (Hewlett Packard) Labs in 2000. It enables the recording and representation of subtle surface details using a standard digital camera at constant exposure and varying lighting, and software that is free for non-commercial use (Earl et al 2010: 1). PTM has had a range of cultural heritage applications, but had not been applied to textiles or basketry before its use at The National Archives in 2011.

For this trial, the University of Southampton's PTM team used a large dome (~1.5m diameter) fitted on its inner surface with an array 76 lights and a digital camera at the top of the dome. Each test object was placed under the dome, and 76 images were captured, one image for each source of illumination. In the processing phase the 76 images were 'fitted together' to create a single image. The HP PTM viewer allows the user to see the 'fitted together' image and to explore it in various ways (Figuress 3 and 4). The screen grabs show: the 'fitted together image' at the bottom right, the zoom control at the right, the green disc for lighting control (via the cursor) at the top right, and the view selected by the user on the left, with both scale and lighting direction controlled by the user. By moving the cursor, the user selects the lighting and the magnification s/he wants, enabling the image to be virtually re-lit. Being able to control the scale and lighting easily means

the user has a proactive and visually exciting examination experience. The results of the initial test (on plain-weave Assamese cotton cloth, a small woven palm-leaf basket, two wax seals and gold-work embroidery on silk) were very positive, attracting a lot of interest, both by specialist researchers and those organising education and outreach activities.

Further image capture with PTM is planned for summer 2012 at The National Archives to explore and present designs from the Board of Trade Design Register; woven textiles, lace and basketwork have been identified as priorities for the next phase of PTM, together with wax seals from other series in the archives. Online delivery of the resulting images via the experimental web pages of The National Archives is under consideration. The large file sizes resulting from PTM mean that its use in an archive setting is likely to be restricted, e.g. to exploiting hard-to-decipher seals or for defined education activities.

PTM can be carried out without a dome, using a shiny sphere as the source of the reflectance data. This means that the technique can be applied in wide range of settings and scales, from microscopic to historic landscape. The University of Southampton team is keen to explore other collaborations and "*in particular the application of this technology to other material types and to further interpretive goals*" (Earl et al 2012:10).

Touching online: haptic technology

Haptic technology provides the computer user with the physical sensation of touching an object depicted on the screen (Geary 2007:241). As human beings acquire much of their knowledge about the world through the texture, form and weight of materials, the ability to touch is important for understanding and user-engagement (Pye 2006). Geary has explored the potential of haptic technologies for learning and assessing conservation skills in backing removal (Geary and Sandy 2004) and in print-making (Geary 2007). Haptic technology is already in use in veterinary education, e.g. in learning to make incisions and to conduct gynaecological examinations of cows http://pressandpolicy.bl.uk/content/Detail.aspx?ReleaseID=1267&NewsAreaID=2.

As part of the Clothworkers' Research Fellowship, arrangements were made for David Prytherch of Birmingham City University to demonstrate a portable console which enables the user to experience the physical sensation of touch via a stylus-based haptic interaction (Prytherch and Jefsioutine 2007). A small carved netsuke is shown on the console's screen; by holding and moving a pencil-like stylus, the viewer can move around the on-screen netsuke and differentiate its smooth and rough surfaces. Geary (2007: 246) notes that predicted requirements of haptic technologies in the cultural heritage sector, e.g. the virtual handling of fragile collections and enhanced access by the visually impaired, currently outstrip technological capabilities. However, the online retail industry recognises the importance of touch in assessing the quality of goods and this commercial driver may stimulate the necessary investment for technological development, which may lead to cultural heritage applications.

Closing remarks

This brief exploration of 'work in progress' has sought to demonstrate that texture, and other key features of textiles, basketry and related materials, can be captured and presented via digital technologies. No decision has been made about the online delivery of the designs (*representations*) in the BT Design Register. Discussions continue about the online delivery of these 3 million or so designs to a range of users.

Technological capacity is just one factor amongst many collection management issues, notably resource allocation and sustainability.

The possibilities of 3-D imaging for cultural heritage applications are being actively explored, e.g. by an international research collaboration called the 3D-COFORM, which recently held an excellent exhibition called 'RESHAPING HISTORY' at the University of Brighton Gallery. As stated in the exhibition flyer, "3D-COFORM promotes state-of-the-art 3D tools and expertise within the cultural heritage sector, and unites specialists from across Europe." Find out more at www.3d-coform.eu.

Acknowledgements

I am pleased to acknowledge the support of: The Clothworkers' Foundation; Nancy Bell, Dr Anna Bülow and Dr Chris Owens of The National Archives; the archivists, artists, conservators, curators, designers and historians who contributed to consultation events; Dr Graeme Earl and Dr Hembo Pagi of the University of Southampton, for demonstrating polynomial texture mapping; Dr David Prytherch, Haptics and Computer Interfaces, Birmingham Institute of Art & Design, Birmingham City University, for demonstrating the haptic console; Mike Stapleton of 'System Simulation' for information on image browsing.

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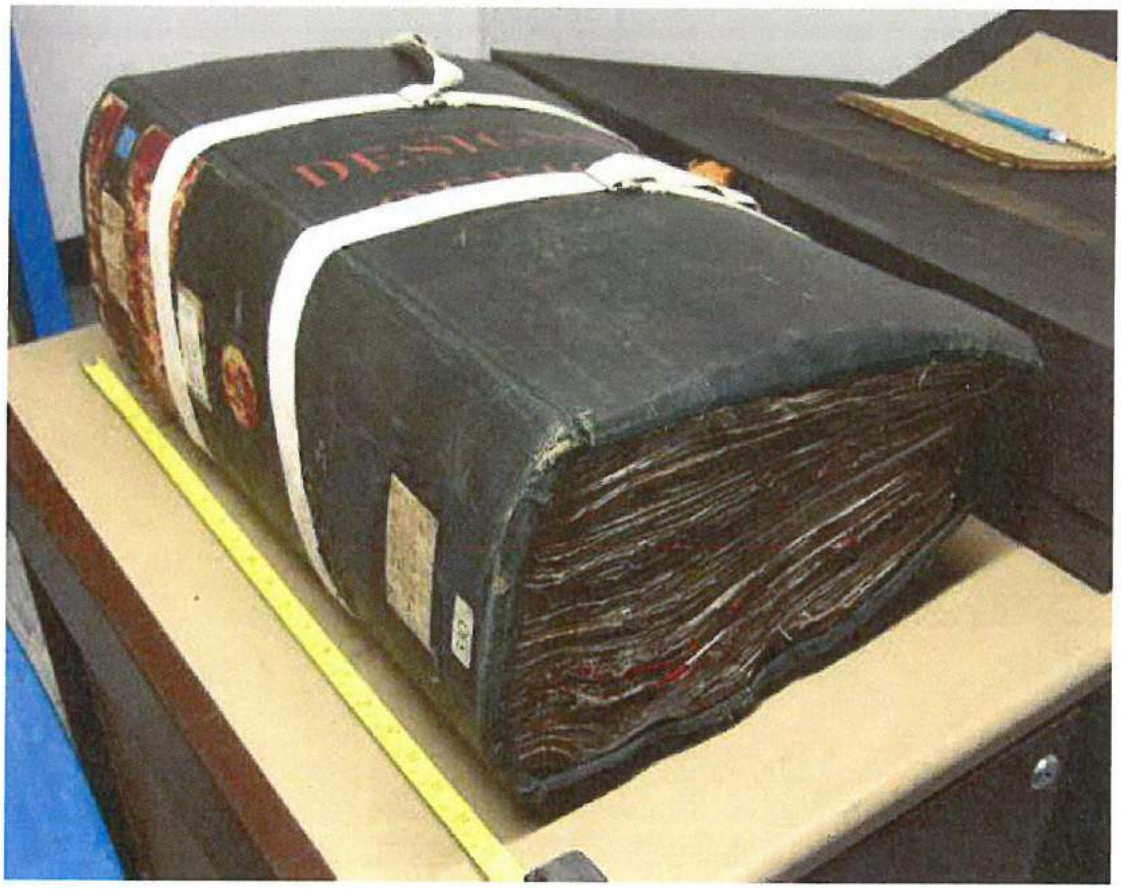

Figure 1
One volume of representations from the BT Design Register.

Figure 2
One page of representations, including knitted wool mittens.

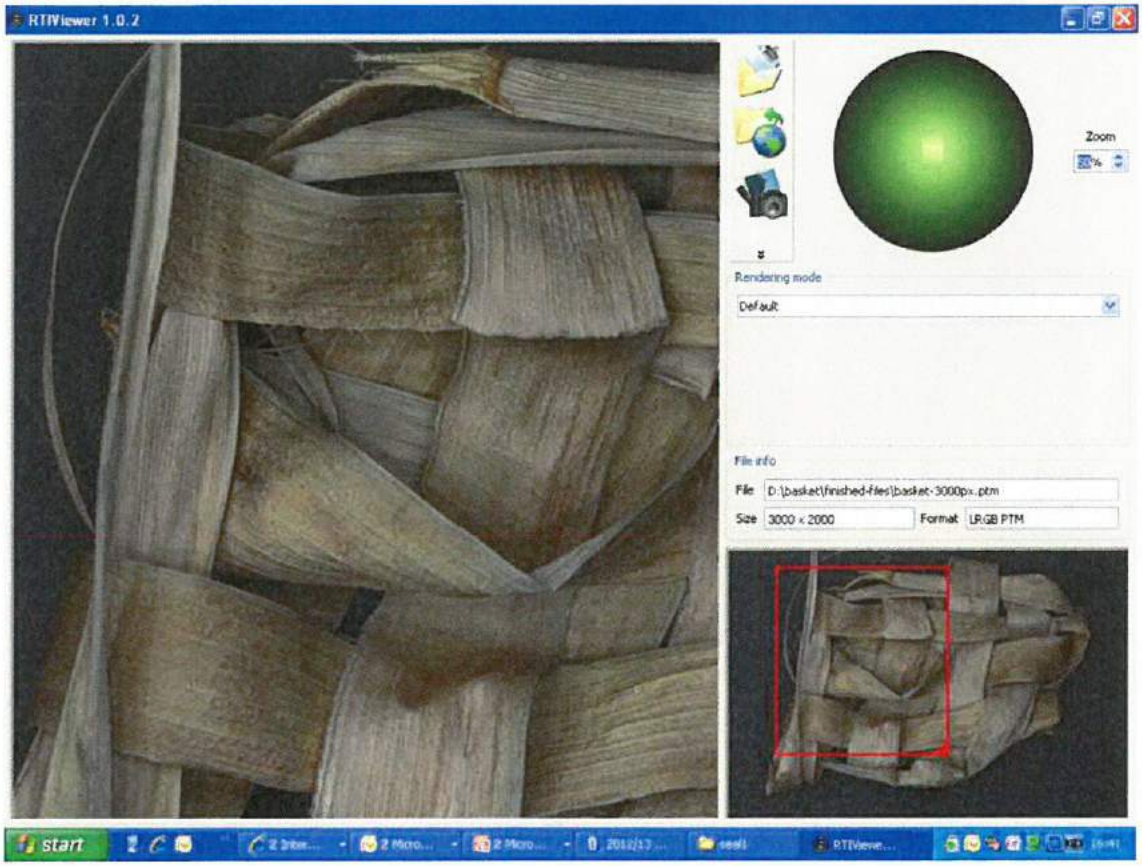

Figure 3
RTI viewer showing PTM of basket, with zoom set at 50%, and cursor moved to centre of green lighting control to give even virtual lighting.

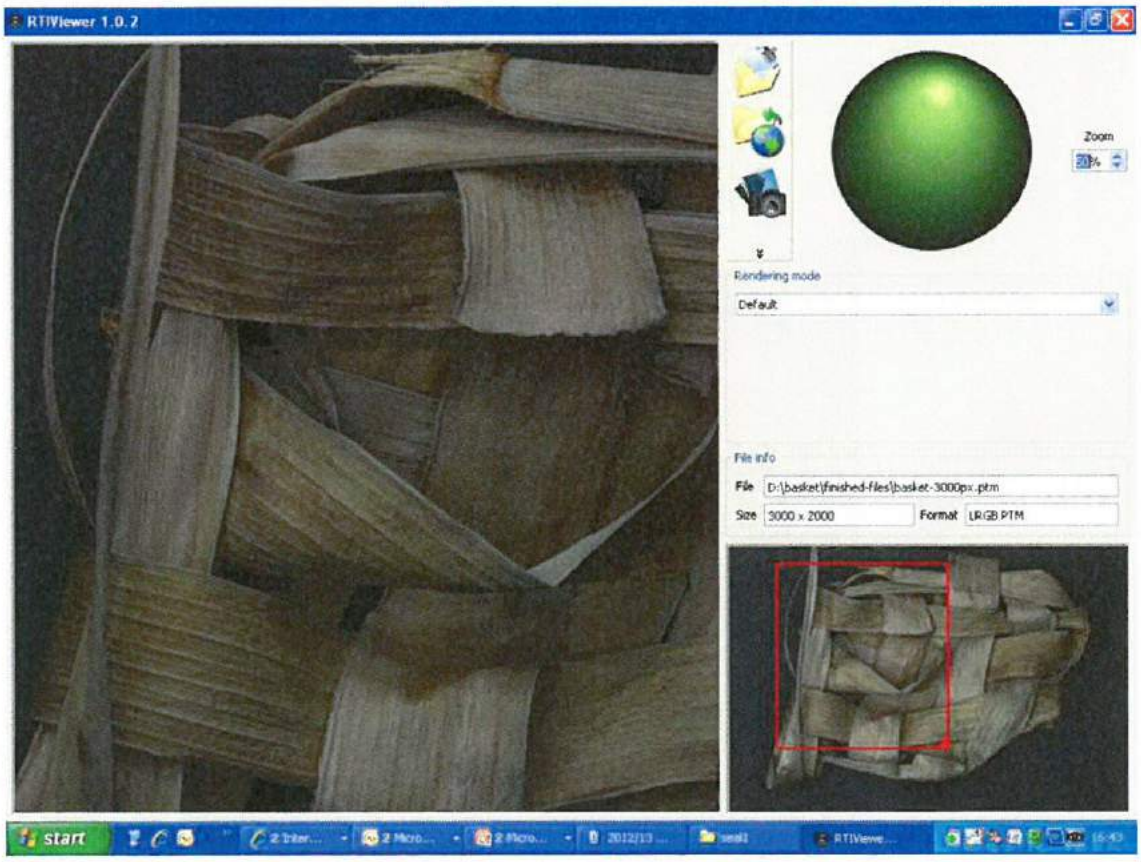

Figure 4
RTI viewer showing PTM of same basket as Figure 3, with zoom set at 50%, and cursor moved to give raking virtual lighting.

A work of Patience and Perseverance – the conservation of a large 16th century appliquéd hanging

Ksynia Marko – *Textile Advisor and Studio Manager, National Trust*
Rachel Langley – *Textile Conservator, National Trust*
Philippa Sanders – *Textile Conservator, National Trust*

Introduction

This paper centres around one of five original hangings of monumental scale that were commissioned by Elizabeth Cavendish, Countess of Shrewsbury and made for Chatsworth in the 1570's. One of the hangings bears the date 1573 above a heraldic medallion signifying the Cavendish and Talbot alliance. In their day they would have testified to the wealth and high status of their owners and demonstrated the extent of their thinking and knowledge. More importantly for current viewers, through the subject matter chosen, they also tell us a great deal about Bess's attitude to family life and what she perceived to be the responsibilities of women.

Four of the five embroidered and appliquéd hangings, each depicting a Noble Woman and the personification of particular virtues, still survive. The Noble Women depicted are Arthemesia, Zenobia, Lucrecia and Penelope with Cleopatra forming the fifth hanging, now only surviving in fragments. Each hanging was constructed in the manner of a theatrical backdrop and designed around a classically inspired architectural setting with arches framing the figures. Expensive silk velvets, lampas, tissue, cloth of gold, and other plain and patterned fabrics and braids are cut and arranged to form the design. Each hanging measures approximately 3 metres high by 4 to 4.5 metres wide and would have dominated the room, creating a powerful sense of confidence and grandeur.

By 1601 the five hangings appear at Hardwick Hall, which was then the home of Bess, where they are mentioned in the inventory as hanging in the Withdrawing Chamber, but evidence would indicate that they were later moved around the house.

By the 19th century they were recorded as being used in the Entrance Hall, nailed to wooden frames and used essentially as draft excluders! They suffered extensive damage whilst hanging here, especially the velvet background fabric. Evelyn, Dowager Duchess of Devonshire, born in 1870, recorded in her 1945 notebook that, "*They were hanging loose and much decayed, so I reluctantly put them under glass to save them from complete destruction.*" This she did in 1909, after undertaking repairs, mainly in the form of painting in areas of loss, applying fabric patches and working coarse stitching to hold down fragments.

Early photographs show the entrance hall with two panels mounted into glazed screens at the far end, Penelope being sited in the left hand screen, where she hung until July 2011.

In November 1968 Mr John Nevinson, formally of the Victoria & Albert Museum, visited Hardwick to gather information for his seminal work, the 'Catalogue of English Domestic Embroidery of the Sixteenth and Seventeenth Centuries'. To quote from his unpublished report,

> *"The purpose of my three day visit was to examine closely the large framed pieces, which are difficult to look at when the house is open to the public. Scaffolding was erected on the Chapel stairs and movable trestles were provided. It did not prove practicable to do as much as I had hoped. The glass of the first hanging examined (Arthemesia) was in three sections,*

held by two vertical metal strips, and when the side moulding and frame had been removed, only the top of the frame was found to be holding in three sheets of glass, each weighing perhaps a hundredweight! ...This is an unsuitable arrangement and has made the frame neither dust proof or airtight...."

Just as was discovered in the later survey!

Before abandoning his attempt at gathering more information Nevinson was able to confirm that the embroidered date of 1573 was original. He also examined the panels mounted into double sided screens in the Entrance Hall and exclaimed that, *"If ever either of these frames had to be opened, I would not like to miss the chance, even at shortest notice, of coming to examine them."*

Survey of the hangings 2007

Sadly Mr Nevinson never had a chance to have a closer look before his death in 1985, but in 2007, after years of patience and perseverance, the National Trust published the catalogue of the Hardwick embroideries written by Santina Levey, and in the same year the frames were again examined and the hangings surveyed by Ksynia Marko and Melanie Leach and the practicality of their removal ascertained.

The size of each hanging and difficult accessibility of those displayed on the Chapel Landing meant that their examination had to be carefully planned. A fixed scaffolding platform had to be erected across the Chapel Landing stairwell to access the Arthemesia hanging and a scaffold tower was used to access the Zenobia hanging. Those in the Entrance Hall could be accessed using ladders.

The survey of all the hangings took two conservators 12 days on site and 14 days to collate the information and write up the report. Each hanging was divided into 20cm vertical sections running across the width and each section numbered, left to right. The sections were measured and delineated by threads secured at the top and bottom of the frames using archival tape. The height of each hanging was further divided into quarters and labelled A-D. This provided a grid which allowed the close and systematic examination and subsequent estimate of each grid section.

Details of the various types of treatment to be undertaken for each section, for example surface cleaning, removal of old repairs, applying net or crepeline overlays, were detailed on a spread sheet, giving the number of hours for each and thereby the overall estimate for remedial conservation. Additional hours covering more general tasks such as preparation and dyeing of materials, documentation and photography, packing and on site work were subsequently added. Photographs and diagrams were used to plot areas of weakness and mould spots, again using the grid to mark these as accurately as possible. Areas of different materials were noted to gauge the numbers of dye recipes required for the preparation of supporting fabrics and net overlays. Finally a contingency sum was added to allow for any 'hidden' problems not visible due to the frame. In 2007 the overall cost of treatment for Penelope was estimated at being £115,988, plus just under £10,000 for on site removal and re-instatement.

The Penelope hanging had been identified as a suitable pilot project in order to test the treatment proposal and estimate (Figure 1). By the end of 2010 funding had been secured from the Wolfson Foundation to carry out the work to Penelope.

De-installation in July 2011

The on site removal of the embroidery took place within one day, after careful preparation and planning. It was a collaborative exercise led by two textile conservators and two furniture conservators and involved the regional conservator and a number of house staff.

The frame had not been opened since its installation over a hundred years ago. Another similar hanging from the set of Virtues and Vices, Faith and Mahomet, shared the frame with Penelope, being mounted back to back. Due to the frame construction, the glass could only be removed from the side of the Faith hanging. Access to Penelope therefore was only possible after firstly removing Faith from the frame.

A risk assessment was carried out and a clear working space prepared, large enough to take the embroidered panel plus the pre-constructed Correx™ packing box. The route for moving first the glass, then Faith and then Penelope was worked out and walked through with a tape measure. Conservators wore plastic gloves while handling the textiles.

To begin, the beading from around the glass was removed at the bottom and both sides. The top beading was removed just prior to the removal of the glass. A row of seven double suckers were evenly spaced along the glass, at a low handling height for lifting, with single suckers placed higher up for support. Ethafoam™ blocks were put in place on the floor in front of the frame to receive the glass as it came out. They were also placed across the floor and in front of the opposite glazed frame where the glass was to be rested.

Once the glass was removed the stretcher frame with Faith attached was gently levered away out of the frame, however it couldn't be released and the two stretcher frames were found to be attached together midway up the side of the stretchers. After investigation, countersunk screws were detected under the front of Faith, at either side of the stretcher. The screws were not visible from the front as they had been put in place before the embroidered panel of Faith had been tacked down the sides its stretcher. Enough tacks were removed to allow the two screws to be accessed and removed and the two stretchers supporting Faith and Penelope were separated. Faith was then lifted out of the frame and moved across to the opposite glazed frame, in front of the glass that had already been removed.

It was also discovered that the four outer edges of Penelope had been folded over the stretcher by approximately 20cm and secured with tacks. The condition of the folded fabric was found to be extremely poor, especially in the brittle and fragmented silk velvet used for the brickwork. There was no separator between the two stretchers and the Penelope stretcher frame was held in place within the frame by a total of five oval nails skewed at three heights. These were removed and the Penelope stretcher released.

Ethafoam™ blocks were placed to receive Penelope and a folded sheet of acid free tissue placed on top. Penelope was lifted out onto the blocks and the tissue pinned up over the fragmentary lower edge to form an envelope. It was walked through the two glazed frames around to the front to rest against the outside face of its glass. It was supported on Ethafoam™ blocks. Tacks at the three accessible outer edges were removed.

While Penelope was upright and on the stretcher, the front face of the panel was covered with a protective layer of Bondina® (a fine non-woven polyester with a smooth surface). Each strip of Bondina® was overlapped by 10cms and P90™ tape gently placed over the joins. There was an excess of 20cm of Bondina® at the top and side edges, which was folded over to the reverse of the hanging. Tailor tacks were stitched through the Bondina® into the hanging using curved needles and a coloured thread. They were placed along the top and side edges and in two horizontal lines following the architrave at the top with the second stitched line above the tapering pilasters in the lower section of the panel.

The floor space was prepared by vacuuming and then covered with a sheet of polythene. Next, it was very important to prepare all the layers of packing material, ties and lifting straps in order

to reduce disruption to the object when it was in place. Penelope was walked and turned 90 degrees with the front facing the prepared floor. The centre of the packing materials and centre of the Penelope stretcher were lined up. The panel was then slowly lowered with two people walking the stretcher frame down from upright. A further two people kept the lower edge from slipping and two others received the top edge.

All remaining tacks were removed from the reverse and outer edges. The folded over sides of the hanging were turned back and the corners undone. The hanging was then released from the stretcher which was then lifted away. The inside of the glass frame was cleaned and the bare stretcher for Penelope cleaned and reinstated inside. Faith could then be put back into place followed by the glass.

Penelope could not to be transported flat due to access issues. It was prepared for folding in two places over large padded rollers and tailor tacks were placed on the reverse of the hanging where the folds were to be. Five soft rollers were made using bubble wrap and wadding. The top and bottom edges of Penelope were folded over again (so as to fit in the pre-prepared Correx™ box) and padded out with polyester wadding. The sides were left unfolded. The back of the hanging, between the folded over top and bottom edges, was padded out with a layer of polyester wadding. A second layer of needlefelt was placed over that.

The soft rollers were then placed on the reverse of Penelope between the tailor tack markings on the hanging. Using the outermost roller as a support and the needlefelt as a guide, one side of Penelope was brought to sit over the bed of rollers. This was repeated for the other side creating a neat layered package. Finally the layer of Tyvek™ was brought over both sides of the package and secured using the hook and loop fasteners and ties previously put in place.
The base of the box was lined with needlefelt.

The box was moved into position and using the lifting tapes under the needlefelt and the hanging package was lifted into the box. The tapes were left in place for removing Penelope at the Studio. The space between the box and the lid was packed out with additional layers of polyester wadding and bubblewrap before the lid was secured with screws ready for transport to the Studio.

A life size, digitally printed facsimile of the hanging has been attached to the front of the frame for the duration of the conservation work, along with the display of two explanatory posters for the visitors.

Studio Treatment

Once Penelope was delivered to the Studio the hanging was unpacked onto the specially commissioned tables (Figure 2). Due to the heavy padded applique work it would not be possible to roll the hanging as it was worked on, so accessing anything but the edges was going to be problematic. Ksynia, together with a local firm of metal workers, Metalman, came up with a design for a modular table. It consisted of ten tables with folding legs which slotted together, then metal bridges were placed on top of the tables and a second layer of table tops were slotted into position, giving a two tiered table. So as one section of the hanging was completed it could be fed face-down onto the table below. This meant that all work would have to be done from the front with curved needles as it would not be possible to get your hands underneath the hanging.

In order to minimise the amount of handling Penelope was unpacked face down so that the reverse could be cleaned and the support fabric applied. Closer examination of the hanging showed that the appliqués were applied to a linen ground which then had an original linen lining over the back.

As the lining was cleaned with a museum vac and chemical sponges, it was decided to remove and conserve it separately for later re-application.

As the lining was removed several interesting discoveries were made: there were two rolled pieces of red wool fabric stitched to the linen backing, one above Patience's head and the other above Penelope's arm. The purpose of these fabric rolls is not known, Santina Levey was able to examine them and she had not encountered anything similar before.

Several painted outlines denoting the placement of the appliqué pieces were also found on the linen backing. Behind the figure of 'Perseverans' the letters P E R were found, also two number 3's were found, perhaps indicating that this was the third hanging in the set.

The support of scoured linen was applied to the reverse, stitched to the base linen with a polyester thread, working from the centre outwards utilising the double table. As the support was applied the reverse of the backing linen was cleaned using a museum vacuum and micro fibre cloth. Once the linen support was attached across the hanging it was turned over with the aid of padded rollers and drainpipes so that it was face uppermost on the table. Then with great trepidation the Bondina® facing was removed.

At this point it was necessary to reassess the estimate to take account of the areas that had not been visible when the initial survey and estimate were carried out. The most immediately noticeable losses were at the two sides where the dark brown silk was missing, exposing the ground linen (Figure 4).

During the initial surface cleaning with a microvac needle, several discoveries regarding the original appearance of the various textiles were made. In one area where the yellow silk appliquéd column was detached it was possible to lift it up and see that underneath what had at first appeared to be a black silk with a self stripe had in fact originally been a silk velvet with a stripe of cut black velvet pile and a stripe of yellow looped pile. This would have changed completely the visual impact of the hanging, the female figures would have been standing in black portals against a black and yellow striped background. Other small areas where stitching was coming undone gave an insight into how sumptuous the original colours would have been, for example a velvet that now looks a dull, dark yellow was in fact originally a delicate peach silk velvet. All the different types of fabric have been documented using a digital microscope camera (Figure 3).

The initial estimate had been based on a 'light touch' treatment of simply covering the most brittle and splitting areas of silk with nylon net. The success of this treatment would be very much dependant on careful dyeing and colour choice to maintain the subtle colour differences between the original fabrics. Preliminary sample dyeing was carried out, then there was a meeting with the curator, textile historian, regional conservator and house and collections manager to finalise the colour choices and the extent to which any repair stitching was to be removed and any new materials introduced.

One area where it was agreed to add some new fabric was in the narrow black braid above the monograms as it was very noticeable in the areas were it was missing. Following our discussions it was decided to in-fill these missing areas with the selvedge cut from some of the dyed black silk crepeline. In-filling with new material was also used was along the upper edge where damage had been caused when the edge was tacked to the stretcher frame.

The black velvet strip across the top of the hanging was very brittle and curling up, making it very vulnerable to further splitting and loss. In this area the whole strip was covered with the black

nylon net, stitching around the splits and holes to hold the silk flat. By cutting the net away from the monograms it was possible to maintain the definition between them and the black silk.

Another area where it was decided to add new fabric rather than just the nylon net overlay was down the two sides where the dark brown/black silk was missing and the linen ground and under-drawing was visible. With the dyed net overlay alone, the linen ground was still very visible and distracting. In order to tone it down but still be able to see the linen ground and original under-drawing we decide to insert a dyed black crepeline underneath the original black silk. From a distance this gave a solidity to the colour but close up it is still possible to see the linen ground and under-drawing (Figure 5). The treatment of the left-hand side was completed first and the right hand side was treated in the same way before moving on to the main central figures. It is anticipated that the project will be finished in February 2013 .

Another aspect of this project has been the commissioning of a time lapse film which will be used for public engagement when the hanging is redisplayed.

Acknowledgements

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The Project Team

Ksynia Marko	Textile Conservation Adviser, National Trust
Philippa Sanders	Textile Conservator, National Trust
Rachel Langley	Textile Conservator, National Trust
Nadine Wilson	Assistant Textile Conservator, National Trust
Melanie Leach	Freelance Textile Conservator (Survey)
John Hartley/ Allan Baker	Tankerdale Furniture Conservation

Regional and Property Staff

Andrew Barber	Curator, National Trust
Christine Murray	Regional Conservator, National Trust
Nigel Wright	Hardwick House & Collections Manager, National Trust

Freelance Consultants

Santina Levey	Textile Historian
Mike Hemsley	Time lapse photography
Chris Timms	Professional photographic documentation

Central Office Staff

Beth Bottrill	Fundraising, National Trust

References

Levey S M. 2007. *The Embroideries at Hardwick Hall a Catalogue.* Great Britain: The National Trust.

Materials and Suppliers

Correx™ Fluted Display Board	Robert Horne Group Ltd Horse Fair House St Faiths Lane Norwich NR1 1NE
Bondina® 30gsm Filmoplast P90™ Archival Tape Ethafoam™ Tyvek™	Preservation Equipment Ltd Vinces Road DISS IP22 4HQ
Conservation Nylon Net	Dukeries Textiles Ltd Spenica House 15A Melbourne Road West Bridgford Nottingham NG2 6DJ
Silk Crepeline Ref 1630-1, ecru	LeLievre 108-110 Chelsea Harbour Design Centre London SW10 0XE
Linen Uncoated Canvas – 09	V A Claessens Molenstraat 47 8790 Waregem Belgium
Table	Metalman Ltd The Metalworks Midland Road North Walsham NR28 9JR
Dino-lite – USB Microscope	www.dinolite-uk.com European Distribution by: Dino-Lite Europe IDCP B.V. Energiestraat 23-A 1411 AR Naarden The Netherlands

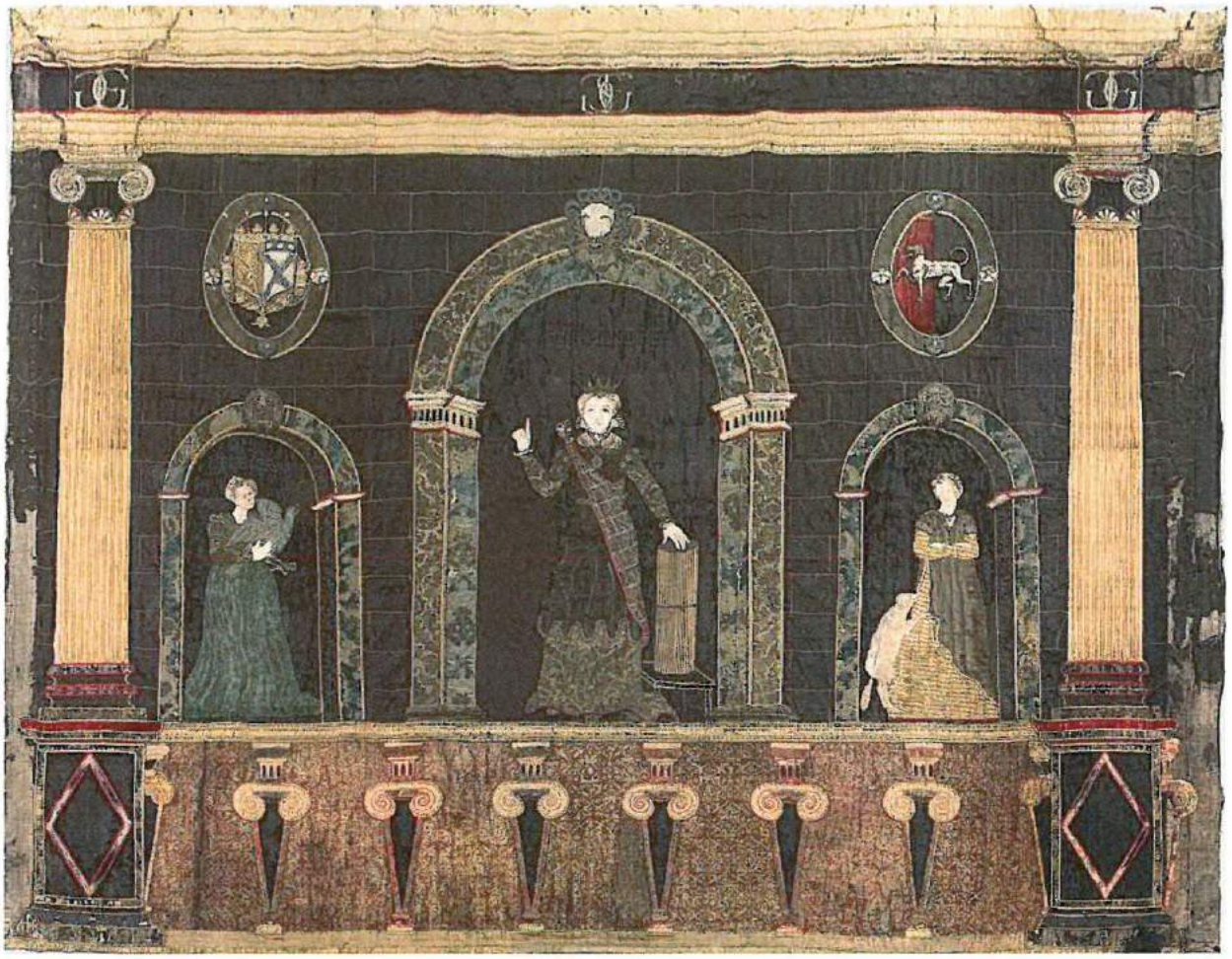

Figure 1

An overall view of the Penelope Hanging once removed from the stretcher frame showing the full extent of the hanging and the damaged areas that had been previously wrapped around the frame.

Figure 2

At the Textile Studio unrolling the hanging onto the specially designed modular two tiered tables

Figure 3

A photograph taken with a hand held Dinolite digital microscope to show the unfaded yellow and black striped velvet. The black stripe is made of a cut pile velvet and the yellow stripe is made from a looped pile.

Figure 4

A detail of the left hand side to show the missing striped black velvet, the ground linen and under drawings are visible.

Figure 5

A detail of the same area following conservation when a dyed black crepeline has been inserted behind the black velvet and overlaid with nylon net.

Armoured and dangerous? The conservation of an iki-ningyo or Japanese 'living doll'

Sarah Glenn
Textile Conservator, V&A

Introduction

The Victoria and Albert Museum (V&A), London, has three examples of iki-ningyo in its collection. Iki-ningyo (*iki* –'living' and *ningyo*- 'doll') are Japanese life-size figures that were made to look as realistic as possible. Popular in 19th century Japan, they were often displayed both individually and in tableaux.

The conservation and display of one of the iki-ningyo wearing a full suit of samurai armour will be discussed in this paper. The armour itself is made of many materials including iron, lacquered leather, brocade, silk damask and silk braid, with copper-gilt applied ornaments and metal thread embroidery. The figure is mounted on an original 19th century life-size Japanese mannequin, made from straw, newspaper and wood with a painted finish.

The variety of materials in the armour and doll meant that a large collaborative project between several different conservation studios at the V&A was required, including textiles, furniture, sculpture, paintings and the mount workshop in order to prepare the doll for permanent display in the Toshiba Galleries of Asian Art.

Iki-ningyo objects

In Japan, iki-ningyo and iki-ningyo tableaux have long been considered a form of 'entertainment' rather than art (rather like the figures seen in Madame Tussauds in London) and it is only recently that the iki-ningyo have begun to be studied as an important part of Japanese artistic heritage (Naoyuki, 2010) . Examples by those considered masters of the form, Matsumoto Kisaburo (1826-1892) and Yasumoto Kamehachi (1828-1900) could, until recently, be found at the Smithsonian, Washington DC and the Detroit Institute of Arts in the USA. The pair of sumo wrestlers in the Detroit collection, were de-accessioned in 2005 and sold back to Kumamoto City, Kamehachi's home town in south-western Japan (Haruko, 2008). The Smithsonian dolls are currently in storage.

The tradition of iki-ningyo began in the early nineteenth century and evolved eventually to produce models with exceptionally lifelike qualities. Kisaburo and Kamehachi produced figures that were so realistic they were said to be difficult to differentiate from humans. Indeed there is one story of a doll made by Hananuma Masakichi in his own likeness, finished in 1885. He discovered that he was dying from tuberculosis and wished to leave a parting gift to his wife. He bore a hole in the doll for every pore of his body and used his own hair and eyelashes. It was said that the finished statue was so life-like and realistic, people couldn't tell which was the fake even while the real Masakichi stood next to it. The doll was on display in Ripley's 'Believe it or Not' Los Angeles 'Odditorium', until it was badly damaged in the 1996 earthquake (Naoyuki, 2010) . Since then, the doll has not been on display, and still awaits repair.

The V&A owns three iki-ningyo, two wearing full samurai armour, one standing and one sitting and a third female figure kneeling inside a palanquin. The maker or makers of all three is unknown. The conservation of the sitting samurai iki-ningyo was carried out in the summer of 2011, ready for display in the gallery in December of the same year.

Samurai iki-ningyo

This particular samurai iki-ningyo can be thought of in two distinct parts; firstly, the iki-ningyo itself, i.e., the head, arms and mount, and secondly, the samurai armour (Figure 1). The armour dates from the middle of the nineteenth century and was most likely a family heirloom. The doll was probably made specifically to display the armour. The mount, i.e. the wooden box and metal armature was made in the late nineteenth century before the object was acquired by the V&A in 1922 (Figure 2). Of the three V&A iki-ningyo it was in the best condition and required the least amount of conservation, despite initially being assessed as being in a poor condition.

Collaboration and Planning

A large part of the project was the collaboration between the various different conservation studios, which included Textiles, Furniture, Sculpture, Paper, Metals and the Mount Making workshop. A great deal of planning was required in order to create a schedule of work and establish the priorities for treatment.

The initial assessment of the object was carried out by conservators from the Textile and Furniture Conservation studios. Each part of the iki-ningyo was listed and matched to the conservation studio that would carry out the treatment. In this way, the order of treatment could be established and the work fitted in to each studio's schedule.

In the early stages of the process, it became clear that the textiles and lacquer elements of the armour needed the most work. The textile conservation was estimated to take approximately 250-300 hours, bringing the total estimated time to over 450 hours.

Documentation

With over 25 parts required by over five different studios between two V&A locations over eight months, it was essential to keep track of all elements carefully.

A day was set aside for the doll to be undressed. All knots, ties and other fastenings were documented carefully using photographs in order that they could be replaced to their original position once conservation had finished. A large number of images were generated in this way. Altogether there were over 20 fastenings that were undone. The order in which each elements of armour were dressed has particular significance to Samurai warriors (Kyuukei, 1735), and it was crucial to record the original order.

After the doll was undressed, the original mount was revealed. It was found to be constructed of painted black wood, metal tubes, cardboard, straw and newspaper. The newspaper was in both English and Japanese type. All parts of the doll were dismantled ready to be treated by the relevant studio.

Treatment

As the treatment was lengthy and complex, a few key areas of treatment will be discussed.

Kabuto (helmet)

The helmet is made from iron, parts of which are lacquered, lacing, silk ties, cotton lining and painted leather. The helmet decoration, or *maedate*, consists of a beautifully made dragonfly, each limb and wing articulated so that it hovers and moves during wear, and two lateral crests, or wakidate. The lacquer on the neck guard slats, or ita jikoro, is on a leather substrate with iron supports.

The first stage in the helmet treatment, lacquer consolidation, was carried out in the furniture conservation studio by Andy Thackery, HLF Intern. The consolidation formed the majority of the treatment for the helmet and so was the priority before the helmet came to textile conservation. Areas where there was cracked and lifting lacquer on the iron substrate rim were consolidated with an application of xylene followed by a 10% solution of Paraloid B48N (methyl methacrylate copolymer) in xylene. The decorative leather that was beginning to peel back from its corners was re-adhered by coating the metalwork below using 20% Paraloid B48N in xylene. Once the solvent had evaporated, the material was laid flat and heat sealed using a heated spatula to 60 degrees Celcius.

Once this treatment had been completed, the helmet ties were encapsulated in dyed nylon net and stitched in place. The ties had to be strong enough to be used in order to keep the helmet on the head of the iki-ningyo. All of the red ties were encapsulated without removing them from the helmet itself as it was considered too interventive to remove the ties.

Dou Yoroi and Kusazuri (body armour and skirts)

All of the lacquer treatments were carried out before any other conservation as the condition of the lacquer was very fragile in places. These were treated by Shayne Rivers, Senior Furniture Conservator, with various consolidants depending on the bond required.

Although the armour appeared in good condition when assessed in store, many aspects of damage only became apparent when the armour was disassembled and examined more closely. It was found there was significant light-damage to exposed lacquer surfaces, which had caused the change of colour to brown, and loss of gloss. The interior of the dou was unstable, with large areas lifting from the substrate and upper layers of lacquer delaminating at the upper surface. All braided lacquer components had cracks and splits and were delaminating from the substrate particularly along the edges.

The poor condition of the armour meant that the treatment took over 100 hours more than originally estimated. This meant that the schedule for the textile treatment had to be changed slightly to allow for the extra time required to treat the lacquer.

The lacquer was re-adhered with 10 and 20% Mowilith® 50 (polyvinyl acetate homopolymer) in toluene. Facing paper was applied to inside of the dou with 10% Paraloid B72 (poly(ethyl methacrylate-*co*-methyl acrylate)) in xylene. Usually this is a temporary method to consolidate lacquer, but in this case the paper has been left in place due to a combination of time constraints on the treatment and the need to prevent further damage during the mounting process. As it is not visible once mounted, leaving the facing paper seemed the most reasonable course of treatment until more thorough conservation is possible in the future (Figure 3).

Once the treatment of the lacquer had been completed, the dou was passed to textile conservation. The lacing on the skirts was surface cleaned using a low suction vacuum.

Agemaki (decorative tassel)

The decorative tassel, or agemaki, had to be treated *in situ* attached to the dou for two reasons; firstly due to its fragility, and secondly, it was considered too interventive to untie the knot (still with original knot) and remove it. Dyed nylon net was used to encapsulate the silk braid and stitched in place. Net was also used to encapsulate the tassel to prevent further losses in the silk from occurring.

Kote (sleeves)

The armoured sleeves, or kote, were perhaps the most interesting of the textile conservation treatments. The sleeve is made up of four different layers, two cotton linings, the silk damask decorative layer with metal threads, and on top, the iron chain mail, which had been stitched through the top two layers. There was a large area of loss within the silk damask, most likely initiated by light damage, as the area was exposed. The ideal treatment would have been to give the sleeve a full lining support in order to strengthen and consolidate the silk damask and to take some of the strain of the weight of the chain mail. However, due to the construction of the sleeve, all four layers would have had to have been undone, including the chain mail. A full lining support was therefore considered to be too interventive a treatment, in part due to the time restrictions on the project. Instead, a large patch was inserted behind the area of loss in the sleeve, which extended as far as the seams and the point at which the chain mail stitching began, giving the silk damask layer as wide a support as was possible (Figure 4). This was considered a reasonable support as the weight of the iron chain mail would be supported further by the arm, which would be resting on the legs of the doll throughout its display life, reducing the strain directly on the silk damask layer. A net overlay was then also stitched over the top of the damask to create a sandwich support and to protect the loose metal threads of the damask during the mounting process.

Haidate (thighguard)

As with the sleeves, the thighguard, or haidate, also required support, and again the ideal treatment would have been a full support from behind the silk damask fully, partly to eliminate the need to cover the damask texture. However, due to their construction, the best treatment option was to provide a net overlay support in order to prevent future splits and to protect the loose metal warps that had lifted from the damask. Careful dyeing ensured that the net overlay did not obstruct the fabric. These areas were couched and the net stitched into the seams as far as was possible. As with the sleeves, considering that the thighguard would be under very little strain due to the sitting position of the doll, the net overlay treatment seemed the most reasonable. Had the figure been standing, another option may have been considered.

Kobakama (short trousers)

The trousers, or kobakama, being made of silk damask and a silk lining were one of the few elements which were treated purely from a textile conservation perspective. They were in a poor condition being very brittle, dusty and with many splits, having been exposed to light, dust and the weight of the iron dou since the 1922 acquisition and most likely for many years previous to that. Due to the condition and the visibility of the trousers, their treatment was made a priority and a fairly interventive treatment planned. After extensive cleaning using chemical sponges, both the silk lining and the trouser seams were undone. A full adhesive (Vinamul (vinyl acetate-ethylene co-polymer) at 12%) lining of polyester Stabiltex was applied to the inside of the silk damask trousers. The seams were then re-stitched using existing stitch-holes where possible and the pink silk lining reinstated. Additional laid couching was carried out on those areas that required further support.

This part of the treatment took the longest, but was necessary as the trousers were in a poor condition and would have deteriorated even further whilst on display.

The iki-ningyo parts of the object were treated mainly between the sculpture and paper conservation studios.

Head

The head is made from wood and painted. X-rays showed that the head is fairly solid, with a wooden pole nailed through the top of the head in order to secure it to the mount. The top brownish layer was of most concern to the sculpture conservator, Sophia Marques, who suggested that it could possibly be nikawa applied to the top surface to give naturalistic appearance to the flesh. Nikawa is made of animal glue and fine pigments. This layer had been disturbed, maybe whilst attempting to clean it in the past.

The surface was lightly cleaned with Groomsticks on wooden sticks and Wishab sponges. Superficial dirt was removed but the dirtied appearance was in the top brownish layer, which has been disturbed, so the overall appearance could only be improved to a small extent. Various consolidation tests were carried out in order to find the best; the decorative layers are extremely porous and stained easily since any moisture tended to make the pigment of the top brownish layer migrate concentrically. Diluted Lascaux consolidant (butyl methacrylate co-polymer) was sufficient to stick the lifted paint back but needed to be handled with extreme care. The amount of consolidant applied to the surface could also easily stain if not done carefully.

The last part of the treatment of the head, which was in Textile Conservation, was to reduce tangling in the hair. Due to the porous nature of the surface paint on the head and the fragility of the part of the hair attached to the head, the tangling was reduced mechanically, rather than using any humidification technique. The conserved silk headband was also replaced at this point.

Arms

As for the head, the forearms are made of painted wood and were treated in a similar manner. On one hand, the fingers have been repaired in the past and aged shellac could be observed as it was used in excess. There were losses of paint in the fingers and the paint was lifting in several places. Urgent consolidation was required, in particular on the fingers after mechanically removing with a scalpel the excess of aged shellac. Flugger filler (butyl methacrylate and calcium carbonate) was used to build up losses and acrylic colours were used to infill the colour.

Paper

After consolidation of the forearms was complete, they were treated in paper conservation by Richard Mulholland. Where the painted wooden forearm connects to the straw and paper upper arm, there was a large split in the paper. The straw upper arm is attached by means of a metal pin which was not sufficient to hold these parts together, the weight of the wooden forearm causing the tear. There were also numerous areas where the top layer of paper has delaminated. Layers of Japanese Sekishu-shi paper were added dry between the straw core of the upper arms and the top layer of paper. Where there were significant gaps, these were filled with dry bunched and rolled Sekishu-shi so as to provide bulk and allow movement at the joints. Several layers of Sekishu-shi paper were then added using increasingly thick wheat starch paste to consolidate the fills. A final layer of Sekishu-shi was added toned with watercolours. Where the straw and paper core was separated from the wooden forearm, the toned paper was also used to re-attach these elements.

Mount

Due to the curatorial decision to keep the 19th century mount with the armour, a solution needed to be found in order to protect the armour from the black paint and wood of the body of the mount whilst the iki-ningyo was on display, especially as it is likely not to be undressed again for a good number of years. A padded vest was made to cover the wooden box using black silk and

polyester wadding, with Velcro fastenings. The same method was used to cover the arms, the metal armature of the legs, and the knees. The padding on the legs also helped to support the trousers, both protecting them from the straw and painted newspaper and giving padding to the knees, the point at which creases were likely to form as a direct result of the weight from the armour above. It also went some way to support the thighguards which rest on top of the trouser legs.

The mount was required to take the weight of the iron dou so that the silk damask trousers did not get crushed during display. The mount also had to be as invisible as possible around the shape of the stool and to lift the body of the doll up by a small amount, approximately 2cm, in order to dress the mount in the conserved trousers.

The final mount was made from aluminium and steel, powder coated and fixed together using grub screws and wing nuts which can be adjusted slightly to fit the object as closely as possible (Figure 5).

Dressing and Installation

Due to the complex nature of the object and the mount, it was decided to re-dress the iki-ningyo in two stages. The trousers were dressed in the studio so that the mount could be adjusted and placed in the correct position before the weight of the dou was bearing down on the structure. This also allowed for minor adjustments to be made to the trousers and for the correct fastening to be tied on to the soft padding of the mount. The rest of the legs and feet were also dressed, completing the lower half of the doll.

The second stage of dressing was carried out in the gallery next to the case since to move the doll fully dressed from studio to gallery would require many hands due to the weight of the iron armour and a great deal of handling (Figure 6). The aim was to minimise handling as much as possible.

The careful documentation photographs taken when the doll was undressed were simply reversed, and the process of dressing the top half of the iki-ningyo could be carried out easily. In particular it was necessary to reproduce the knots and ties as accurately as possible, as these had not been undone since the doll was acquired by the museum.
A Teflon strip was adhered on the underside of the mount base which helped to manoeuvre the object in to position once inside the case.

Blog

As the treatment of the iki-ningyo was a collaborative project, it was a great opportunity to publicise the work of the conservation department and therefore arranged to write a blog on the treatment of the doll as it progressed.

Due to some difficulties with the V&A website, a newer version of which had just launched, the number of people reading the blog was not as great as the online museum team had anticipated. However, advertising the blog on the V&A's Facebook page helped a great deal, with a large spike in viewers, taking the number to over one thousand.

The comments left were very positive and the blog was considered a success. The Conservation Department is considering using the blog format to document treatments in the future, but it is vital to ensure that each entry is advertised on the V&A's Facebook and Twitter feeds to attract more viewers.

Conclusion

The conservation and mounting process of the iki-ningyo was a large undertaking and one that required good communication and discussion between all of the relevant studios and departments. The order and scope of conservation treatment that was carried out was only possible due to a thorough initial assessment by conservators who specialised in each material on the doll. Although there was a small amount of crossover work, for example, the furniture and textile conservators carrying out surface cleaning of some of the metal, the majority of the treatment was separated out by material. Generally the treatment of one material element of the iki-ningyo did not affect the treatment of another; rather it was the organisation of the order and schedule of treatment that was most important in order to deliver the object on time. It was a great advantage that the iki-ningyo separated into relatively small pieces to work on individually. Where it was not possible to separate materials, a good understanding of and sensitivity to the requirements of all materials present was required. The process which required the most collaboration was between the mount maker and Textile Conservation, in order to provide the most stable, supportive and aesthetically suitable mount possible for all parts of the object.

The conservation of the textile elements was not particularly innovative, but covered the entire spectrum of a textile conservator's work including dyeing, washing, surface cleaning, humidification, adhesive and stitched support. The challenge on the project was to work as efficiently as possible in order to deliver the project on time. This project was also a great opportunity to learn about the conservation of other materials that do not usually pass a textile conservator's bench, and to see a large scale collaborative project from beginning to end. In conclusion, the Samurai iki-ningyo may have initially appeared a more daunting project rather than just armoured and dangerous, but through careful and thorough planning, the collaborative conservation treatment and eventual display was a success.

Acknowledgements

With thanks to Shayne Rivers, Senior Furniture Conservator, Andy Thackery, HLF intern, Furniture Conservation, Sofia Marques, Sculpture Conservator, Sophie Wills, Metals Conservator, Richard Mulholland, Paper Conservator, Greg Irvine, Senior Curator, East Asia, Jan Bourne, Web Content Manager, On-line Museum and Marion Kite, Head of Furniture, Textiles and Frames Conservation. Thanks also to Sandra Smith, Head of Conservation for permission to publish.

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http://www.anomalies-unlimited.com/Death/Masakichi.html Accessed: 11 April 2012

Suppliers

Flugger filler	Conservation Resources (U.K.), Ltd. Unit 2, Ashville Way Off Watlington Road Cowley Oxford OX4 6TU
Japanese Sekishu-shi paper	Masumi Paper 4-5-2 Sugamo Toshima-Ku Tokyo 170-0002 JAPAN
Lascaux, Mowilith® 50, Paraloid B48N, Paraloid B72	A P Fitzpatrick 142 Cambridge Heath Road London E1 5QJ

Figure 1
Sitting samurai iki-ningyo before conservation (M.55-1922).

Figure 2
The original mount after undressing.

Figure 3
Inside of the iron dou after conservation; the facing paper is left applied to the object.

Figure 8
Inserting the silk patch behind the silk damask layer of the sleeves (kote).
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Figure 7
The iki-ningyo sitting on the new mount, designed to hold the weight of the iron dou.
© Victoria & Albert Museum

Figure 6
Dressing the iki-ningyo in the gallery during installation.
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POSTERS

THE SURVIVAL OF VALENCIAN SHOULDER SHAWLS: STUDY OF THE APPLICABILITY AND SUITABILITY OF DIFFERENT CONSOLIDATION PROCEDURES ON HISTORIC TEXTILES.

E. Montesinos-Ferrandis, S. Vicente-Palomino*, D.J. Yusá-Marco, L. Fuster-López, N. Arbues- Fandos
1. Instituto Universitario de Restauración del Patrimonio, Universitat Politècnica de València, Camino de Vera sn, 46022, Valencia, Spain.
Corresponding author: svicente@crbc.upv.es

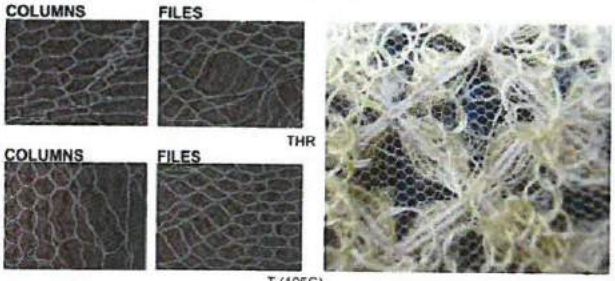
A particular type of accessories known as "shawls for shoulders", became widespread among the working classes at the end of the XIX century. They were daily warm clothes that diversified its typologies and materials. One of the most elaborated, known as "cuello", was tailored with tulle, goat hair and silk, profusely decorated with detailed embroidery, sequins, ribbons, lace, flounces and trimmings.

Damage present in such particular artifacts is mainly associated to their use and continued manipulation as well as to the fragility of the constituent materials. Textile conservation is usually carried out through the use of an auxiliary textile as reinforcing support. The proper choice of the fabric support is commonly determined by the structural and aesthetical needs of the piece to be treated. However, the specific characteristics of this kind of accessories and the variety of constituent materials demands a review of consolidation methods and materials.

This poster presents two case studies corresponding to two different different shoulder shawls where the need to balance structural effectiveness, chemical stability as well as aesthetic interaction with the constituent materials of the object strongly determined which reinforcement textile was needed in each case. For this purpose, several mock-pus were prepared simulating the original textiles and the physico-mechanical and chemical characterization of both materials was carried out through light microscopy, FTIR-ATR, colorimetric measurements and tensile tests before and after artificial ageing.

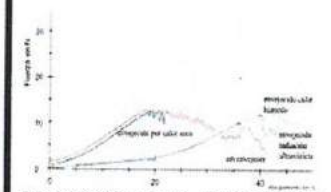
NYLON NET REINFORCEMENTS: EXAMPLES

One of the mesh lining most commonly used is nylon monofilament, a hexagonal-shaped and fine mesh textile. Nylon monofilament's weight is usually around 0,00103gr/cm² and it is also used for consolidation purposes in degraded historic textiles given its transparency and malleability.

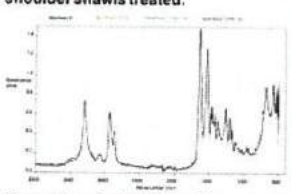


Macro obtained from mechanical tests on specimens of nylon monofilament.

Macro of the consolidation with nylon monofilament of one of the valencian shoulder shawls treated.



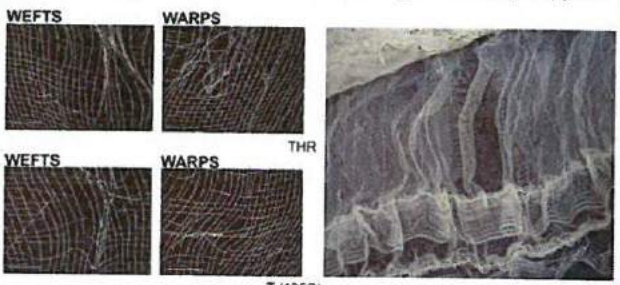
Force-strain values obtained from mechanical tests on samples of nylon monofilament subjected to several cycles with differents aging agents.



IR spectra of nylon monofilament net unaged and subjected to several cycles with differents aging agents.

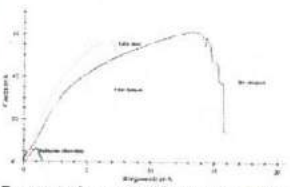
SILK CREPELINE REINFORCEMENTS: EXAMPLES

Crepeline is a plain open weave 100% silk fabric with similar weft and fill yarns that results in a semitransparent light textile (0.00153 g/cm²). Crepeline is usually sewed to degraded textiles for consolidation purposes both from the front (given its transparency) or also from the back, acting as auxiliary support.

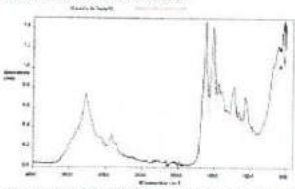


Macro obtained from mechanical tests on specimens of crepeline silk.

Macro of the consolidation with silk crepeline of one of the valencian shoulder shawls treated.



Force-strain curves from unaged and aged silk crepeline samples after different time exposures (h) to differents aging agents.



IR spectra of silk crepeline unaged and subjected to several cycles with differents aging agents.

This is an on-going project. Despite previous experiences related to consolidation materials and methods clearly show that the choice of any reinforcing material depends on the specific needs to solve, preliminary results evidence that many of the tested fabrics do improve the stiffness, strength and stability of the treated textiles without dramatically interfering their aesthetic original appearance This research shows that there is a direct relationship between the weight and density of these reinforcement fabrics and their ultimate tensile strength, which is equally influenced by directional factors within the reinforcement fabric: weft or warp in the case of silk crepeline and row or column in the case of nylon net. Nylon net (column direction),showed the highest breaking strength. Equally interesting, nylon net showed an excellent response to ageing and a high degree of transparency.

ACKNOWLEDGMENTS
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Evaluating painted surface treatments of the National Gallery of Australia's Ballets Russes costume collection

By Hannah Barrett, Textile Conservator NATIONAL GALLERY OF AUSTRALIA

Introduction

This research evaluated the effectiveness, appropriateness and success of several textile consolidation treatments undertaken at the National Gallery of Australia (NGA) prior to 2008. These treatments were carried out on costume pieces from the Gallery's Ballet Russes costume collection. Costumes undergo considerable handling when prepared for exhibition, requiring them to be flexible and structurally sound. A consolidated costume therefore needs to remain flexible and retain the drape quality whilst protecting and strengthening the integrity of the painted surface. The Ballet Russes costumes were recently displayed for four months as part of *'Ballets Russes: the art of costume'* exhibition at the NGA, and some will travel internationally in the future. Three painted costumes from the NGA's Ballets Russes collection were selected and assessed for this research as they had been previously treated using different consolidation methods and materials. Consolidants were considered and evaluated according to adhesion, appearance and flexibility.

Acc. Nos: 71.170.30.A
Title: Costume for a Spirit of the Hours
Ballet: Le Pavillon d'Armide
Designer: Alexandre Benois in 1909
Description: yellow cotton flannelette jacket with couched cotton lining and painted with metallic and other paint decoration
Consolidant: 20% Mowilith DM4 in deionised water

Treatment in 1989/90

20% **Mowilith DM4** in deionised water was chosen as previous tests to best fit the criteria of colour stability, flexibility, surface appearance, adhesion and low tack upon drying against 15% Mowilith 4 SS, 10% Paraloid B72, 30% BEVA and 10% Mowital 4 SS all in deionised water. The maximum wet gap for the 20% Mowilith DM4 in deionised water was 1.4mm.

20% Mowilith DM4 in deionised water was brush applied in a dabbing motion to the front surface of the flaking paint. The water as the solution partially dissolved the paint binder which allowed the flakes to be re-adhered as well as partially reforming the paint layer. The dried paint layer drawn to the flaking. The substrate had softened slightly.

Observations in 2012

Adhesion	Appearance	Flexibility
• Overall the adhesion remains very good • Image comparison – no perceptible change over time • Close inspection – several minute flakes lifting and some loose bits	• The metallic silver paint remains lustrous and reflective without being shiny • No discoloration associated with the breakdown of the adhesive or ringing related to the application process	• Flexibility is appropriate for textile fragility, type and age • Consolidant is not stiff or brittle from age

Conclusion

The 20% Mowilith DM4 in deionised water solution used to consolidate the powdering and flaking paint on the costume remains effective and stable 22 years after treatment. The adhesion is still very strong and there is no overall change in the appearance.

Acc. Nos: 71.20.72.A
Title: Robe from Costume for Finale
Ballet: L'Oiseau de Feu
Designer: Natalia Goncharova in 1926
Description: magenta velvet robe with applied couched cotton tissue and gold metallic paint decoration
Consolidant: 10% w/v Gelatine in deionised water

Treatment in 2007

Rate scale for consolidant chosen is unknown.

10% **w/v Gelatine** in deionised water was applied with a brush warm to assist flow under the paint flakes. The consolidant was heat set to reduce the risk of the magenta dyed wool bleeding into the lining fabric.

Observations in 2012

Adhesion	Appearance	Flexibility
• The bond between the paint layer and textile is strong • There are some loose flecks of gold paint on the costume in the consolidated areas, some from areas not previously consolidated	• The areas of extensive consolidation are quite shiny and reflective, and in some cases slightly opaque in appearance	• The metallic paint is inherently stiff but the consolidant has resulted in increased stiffness, however the areas treated by within panel discussion which is unavoidable and receives little flexion when handled correctly • Cracking and flaking in this area may occur from increased handling associated with a travelling exhibition

Conclusion

The bond between the fragmented paint layer and wool substrate can be considered successful as it is strong. However this has been compromised by the resulting shiny, reflective and opaque finish, and the increased stiffness of the textile. Consideration will have to be given to the painted areas beginning to become fragile which were not previously treated.

Acc. Nos: 2002.40
Title: Tunic
Ballet: Polovtsian Dances
Designer: Georges de Chirico in 1932
Description: unlined wool felt tunic with couched cotton lining and multi-coloured block, blue, yellow, orange, purple and red paint decoration
Consolidant: 1% Isinglass in deionised water

Treatment in 2008

1% **Isinglass** deionised water was chosen in previous tests to best fit the criteria of colour stability, flexibility, surface appearance, adhesion and low tack upon drying against 1% Methyl cellulose, 1% Isinglass, 1% Hydroxy propyl cellulose Klucels and 1% Lascaux 1% with 0.6% at 90:10 each. The Methyl cellulose had surface shine, was slightly stiff and did not hold pigment when the substrate was flexed. Isinglass was matte, more flexible and a little less stiff and held the pigment in place when the substrate was flexed. Lascaux was very strong, matte but somewhat brittle and didn't retain the cupped paint as well as the Isinglass. The Klucel was weak at lower concentrations and at higher concentrations was very shiny on the surface of the paint.

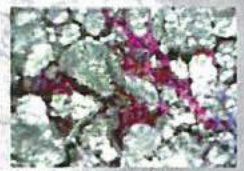
Treated 1% Isinglass in deionised water was applied with a fine brush warm to the areas of lifting and cupping paint. Gentle pressure was applied to ensure a secure bond.

Observations in 2012

Adhesion	Appearance	Flexibility
• Good adhesion even when gently flexed • There appears to be no further loss of paint • The paint flakes could not be lifted when tested with pointed tweezers	• The consolidated area remains an appearance with no gloss • Some of the paint flecks are cupping slightly. It is possible that the flakes are now beginning to crop, but remain adhered	• The costume remains flexible with no apparent increase in brittleness or stiffness

Conclusion

Across all parameters the treatment can be deemed as successful. If the costume is included in travelling exhibitions however care will be needed when dressing and handling, as persistent flexing will cause cracking and damage to the painted surface. The substrate of this costume, wool twill, is considerably more flexible than the other two costumes assessed and the paint layer is relatively thin. The result is it receives compparatively more flex when dressing. Due to the flexibility there is a risk of the costume being treated with complacency during dressing and therefore further damage being caused.



Summary

All of the three treatments can be deemed as effective, as all three successfully consolidated the flaking paint layer at the time of treatment and are still holding up today. At the time each treatment was affective at consolidating the paint layer without affecting the aesthetic or significantly changing the drape quality of the costume. All three treatments are still effective today in consolidating the flaking paint layers particularly the *Spirit of the Hours* costume which used Mowilith DM4 in deionised water as the consolidant and the *Tunic* consolidated using 1% isinglass in deionised water. The treatment for *Finale* using 10% w/v gelatine in deionised water is still effective in the areas consolidated; however the overall effectiveness has been compromised by the shiny appearance of the consolidant.

Each of the adhesives used was appropriate for the particular needs of that costume; however the appropriateness now must be reconsidered. Appropriateness is an important consideration when choosing a consolidant; what is the commercial longevity of the product, what are its deterioration properties and what is the affect on the environment?

Mowilith DM4 is no longer used as an adhesive or consolidant at the NGA as it was discontinued by the manufacturer. Other Mowilith® brand products are available but not currently used by NGA textile conservators at this time due to limited testing.

Gelatine may be considered for textile conservation if deemed appropriate, however it is unlikely to be used as a consolidant, as most consolidation work now carried out by NGA textile conservators is on Pichavai (Indian religious painted hanging textiles). Gelatine is an animal product and is not considered as an ethically appropriate medium for use with Hindu religious textiles.

Isinglass is currently used at the NGA as a consolidant but has environmental implications due to being made from the swim bladder (a by-product of farmed caviar production) of sturgeon. According to the International Union for the Conservation of Nature (IUCN) 23 of the 27 species of sturgeon are on the IUCN's *Red List of Threatened Species*™, meaning 85% of the sturgeon population is at risk of extinction making them the most threatened group of animals listed (Eberhardt 2011).

Through consideration of the parameters of adhesion, appearance and flexibility, and consolidant appropriateness, Isinglass would be judged the most successful, though ethically it is an uncomfortable choice. None of the painted costumes in the Ballets Russes collection was consolidated using Cellulose Ether consolidants, so it was not possible to make a comparison with the treatments used for this research. Cellulose Ethers have been used for other textile conservation treatments at the NGA, but this research project aimed specifically at the consolidants used for these particular costumes, and therefore suitability to go on loan to other institutions and so were not considered as comparable at this time. Assessment of Cellulose Ether based consolidants will be undertaken in the future as they are now commonly used in NGA painted textile consolidation treatments.