Support linings: a comparative assessment of materials and methods for text and image clarity

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ABSTRACT

A paper object may be lined to a secondary support for a variety of reasons that include the repair of damage such as extensive tears, or to reinforce and strengthen an object that is fragile and brittle.

When Polyester encapsulation is not practical or suitable, lining to a secondary support material can impart strength evenly over the object, and may be the most effective option for securely integrating the object.

Any tissue lining will affect the clarity of the text and images on the lined side of the object. This study investigates a variety of different lining materials and techniques in current practice to determine the most transparent method possible.

Mock objects were lined to thin Japanese tissue and Lens tissue with wheat starch paste, methylcellulose, hydroxypropyl methylcellulose and combinations of the above. Different methods of pressing and drying were employed. Heat set tissues and fine polyester support fabrics were also tested. The results were assessed visually and with a densitometer to compare the transparency of the tissue lining, and the clarity of text and image on the tissue side.

KEYWORDS

support, lining, opacity

BACKGROUND

A paper object may be lined to a secondary support for a variety of reasons; these may include the repair of damage such as extensive tears, or to reinforce and strengthen an object that is fragile and brittle. When a lining is applied to an object, it may obscure images and information on the side to be lined, or change the appearance of the paper (McAusland & Stevens 1979). But, in some situations, an object may be particularly fragile or damaged, and lining may be the most suitable option for the overall preservation needs of the object.

The AIC's Paper Conservation Catalogue, Chapter 29, 'Lining', warns that:

> The lining should not obscure notations, documentation or any other data on the verso of the art object. A compromise is sometimes necessary in order to save the object physically. As transparent a lining tissue as is appropriate to the object should be selected. (Owen 1988, p.4).

A review of available literature indicated that linings over images and information are either not carried out, or are not written about. Beyond the brief mention of 'as transparent a lining tissue as appropriate' as described above, no other information could be found on how conservators approach lining such material, or how to ensure the most transparent result possible for the highest clarity of text and image. The AIC's Paper Conservation Catalogue also mentions the use of a window lining in similar situations (Owen 1988), but apart from the use of a transparent tissue, it does not offer any further suggestions.

This study investigates the use of a variety of different lining materials, adhesives and drying/flattening techniques in current conservation practice, including those used in the textiles and paintings disciplines, to determine the most transparent method possible for use in treating material with information or images on both sides.

CONTEXT

The following treatments preceded the investigations into lining transparencies, and were effectively, the instigators in trying to determine how best to approach these and other similar treatments. This research does not recommend linings be applied over original artwork or other particularly significant material. The objects below could be regarded as the hypothetical objects to be lined in this study. They are all part of the Australian War Memorial's Research Centre collections, and therefore have to be made physically available for research and access.

'Greater Asia' newspapers

In 2009, a group of English language Japanese propaganda newspapers from the Second World War arrived in the Memorial's Paper Laboratory with thick packing tape applied over the recto and verso of each sheet. They had originally been cut into squares by Australian servicemen in South East Asia for use as toilet paper. The pieces were not subsequently used as toilet paper, but were collected together by the donor, numbered in pencil, and joined together into their original format with thick brown packing tape applied to the recto and verso. After tape and adhesive removal, lining to tissue was determined to be the best option for these papers. Each tabloid-size page was in approximately 14 pieces; if placed in a Melinex® sleeve, fragments might shift inside the encapsulation. If left in separate fragments, there could be useability, accessibility and security issues.

Lining would impart strength evenly over the object, and would be the most effective option for securely integrating the object. The primary drawback of this treatment was that the clarity of the text and images might be negatively affected by this treatment option.

Booklets

A treatment that is fairly common at the Australian War Memorial is the repair of booklet and pamphlet material. A typical object might be a First World War era theatre program, stapled at the spine. Externally, the paper or card cover will generally have text and details relevant to the theatre and performance, while the inside of the cover will mostly have printed advertising. Often this type of material has been stored in garages or attics and is in quite poor condition when it reaches our collection. Covers may be heavily damaged by water, mould, insects and corroded staples. Generally the spine area will be torn and in particularly poor condition. In these cases, individual tear repairs do not provide the

even, overall strength that a lining will provide. Even though the spine can be reinforced with a second tissue strip, the strength of the lens tissue may not provide adequate reinforcement, and a light but strong Japanese tissue is used in preference.

Experimental

Experimental work was carried out to determine whether or not there is a significant difference at all between materials and methods, and if so, which materials and methods used to line an object will be the most transparent and least obscuring of detail. Samples were made to cover a number of different materials and methods in current practice for creating a lining with a transparent support material. Once lined and dried, the samples were examined visually and with a densitometer to assess the level of transparency achieved with each variation of support, adhesive and lining method.

MATERIALS

Papers and Media

Two types of paper samples were prepared:

- office paper with black drawing ink as a solid black and a light grey wash for the middle tones applied by brush and allowed to dry overnight, and
- book papers cut from a 30 year old paperback.

Photocopies of the Kodak® grey scale were initially tried and rejected, as there were difficulties with the lining tissues adhering to the photocopy media, most likely due to its resin based binder on the surface repelling the aqueous adhesives (Nicholson 1989).

Adhesives

The adhesives used were:

- sieved wheat starch paste diluted with deionised water to a skim milk type opacity
- methylcellulose (low substitution) was mixed with deionised water to achieve a similar consistency
- methylcellulose and wheat starch mixture at the ratio of 1 : 1
- 70% w/v hydroxypropyl methylcellulose (HPMC) in ethanol
- 10% w/v Paraloid B72® beads in a 90 : 10 mixture of ethanol : toluene
- 20% w/v 50 : 50 Lascaux 360® and Lascaux 498®, in water.

Lining papers

McAusland and Stevens recommend lens tissue (L2 tissue from Barcham Green) for lining. As an alternative to Japanese papers, its shorter fibre length gives it little directional strength variation. It is very thin (2.6 gsm) and once applied can 'almost disappear, while allowing inscriptions, collector's marks, etc. to be visible. This lining gives sufficient strength to the original while only minimally interfering with its character' (1979 p.36). In addition though, they report that lens tissue has been at times inappropriately applied over drawings, obscuring the images.

A Honmino Kozo fibre Japanese tissue was selected as a lining that, being light but strong, provides a higher degree of support to the object, as well as a reasonable degree of transparency. At 14.2 gsm it is significantly heavier than the lens tissue.

Crompton® heat set tissue was also selected. Supplier claims that this particular brand of tissue is 'almost invisible' and suitable for local repairs and full lamination (Talas 2010).

Fabric supports for paper have fallen from favour in recent decades, though some are still in use (Owen 1988). In the early decades of the 20th century, fine silk was used as a transparent lining material to both sides of a deteriorated object (McAusland & Stevens 1979), leading to acidity and other problems as the silk deteriorated (Krueger 1995). Personal observations of public access collection material in the Memorial's collection have shown that textile supports such as cheesecloth and linen impart a great deal of strength, and allow for extensive handling. Tetex®, a very fine polyester used for supporting textiles, was selected for testing. No references regarding its use in paper conservation could be located, but its transparency, strength and archival properties (Dancause 2002) were enough for the author to warrant further investigation.

METHOD

Objective and subjective measurements

On the office paper samples, the brush strokes of black ink varied slightly in density as a result of their hand application. Care was taken to apply the grey ink wash consistently, but some noticeable variation in application could not be avoided. To accommodate this variation, it was important to ensure that the before and after readings were taken from the same spot on each sample, so an even enough area was identified within each painted section and marked in pencil with a circle as a reference point.

"Prelining" and "postlining" readings were recorded. Changes in optical density relative to the "prelining" brush stroke were recorded as a percentage figure for each material and method combination.

Optical density is measured on a scale of 0 to 4. For newsprint, blacks should rate between 1.40 and 1.80 (Van Holten 2010). Black inked areas of the prepared samples were recorded between 1.50 and 1.60. Greys varied between 0.07 and 0.20.

The book pages posed some difficulty in obtaining an objective measurement of change. As the densitometer requires an even area of approximately 2 mm to take an accurate reading, measurements could not be taken from the text of the book papers as the type is too fine. The differences between the treated and control samples of book papers were therefore only assessed visually.

Paper opacity

Paper opacity is due to light scattering in the air-filled inter-fibre spaces, while the cellulose fibres themselves are translucent (Homburger & Korbel 1999). The presence of a material that can fill these inter-fibre spaces with a similar clear Refractive Index (RI) to the cellulose fibres will cause the light to transmit, rather than scatter. The result would be to significantly increase translucency. Over-beating of fibres, acid treatments that produce a coating of colloidal cellulose filling inter fibre spaces, or impregnation with oils are methods that have been used to create transparent papers such as glassine and tracing papers. Supercalendering will further reduce air present in these spaces (Page 1997, Homburger & Korbel 1999). Transparency of tissue papers such as lens tissue and Japanese tissues is largely due to their thinness, which is reflected in their light weights.

The Plexiglas® screens for pressing and air drying were selected following the theory behind manufacture of transparent paper. A hard smooth surface, especially if used with a book press, may have an effect on the tissue side similar to calendering. The pressure helps to force out as many air bubbles from the tissue as possible, filling the inter-fibre spaces of the tissue with the adhesive used.

Sample preparation

All sample papers to be lined with an aqueous adhesive were humidified over Reemay® and damp blotters, under Melinex® . Each aqueous adhesive was applied directly to the rough side of each tissue over a Melinex® support and then applied to the sample sheet.

Four systems were selected for flattening and drying:

- Air drying on a sheet of Plexiglas® (in contact with the tissue side)
- Pressing between one sheet of Plexiglas® (in contact with the tissue side), Reemay® and felt (on the object side)
- Pressing between Reemay® and mountboards (on both sides of the object)
- Pressing between Reemay® and felts (on both sides of the object).

In addition to these conventional flattening and drying systems, three heat-set variations were investigated. Each was applied to the object with a tacking iron set at 125 °C through silicon-release Melinex®.

The heat-sets used were:

- Crompton® heat-set tissue
- 20% w/v 50 : 50 Lascaux 360® and Lascaux 498®, in water applied to a Polyester woven fabric (Tetex®), and
- 10% w/v Paraloid B-72®, in 9:1 ethanol : toluene applied to a Polyester woven fabric (Tetex®).

Heat-set linings with Paraloid B72® were found to have a distracting uneven gloss. Toluene : ethanol (60:40) vapour was applied via cotton wool in an upturned jar to solubilise and reform the adhesive. This method was applied for approximately 10 minutes on each area of the lining and significantly reduced the gloss. However, Paraloid B72® did not form an adequate bond between tissues and paper, neither applied as a wet adhesive nor as a heat-set adhesive.

RESULTS

The graphs below represent the change in optical density to areas of black ink after lining to tissue or fabric supports. Changes in optical density relative to the "prelining" brush stroke are recorded as a percentage figure for each material and method combination, e.g 100% would indicate that there has been no detectable change in optical density after lining. Results for HPMC have been omitted where the adhesion was inadequate.

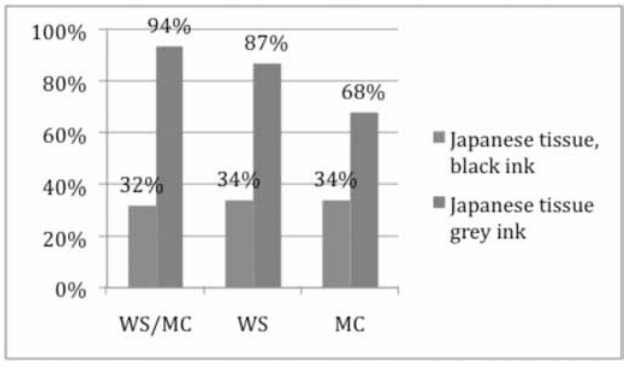

Figure 1: optical density of samples after lining with Japanese tissue and flattening between felts, expressed as a percentage of the before-lining figure.

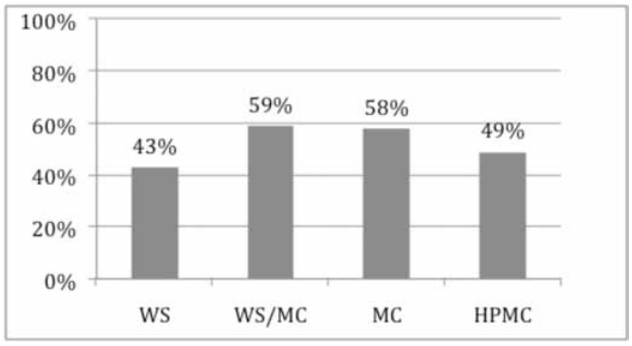

Figure 2: optical density of samples after lining with lens tissue and flattening between plexiglas® and felts, expressed as a percentage of the before-lining figure.

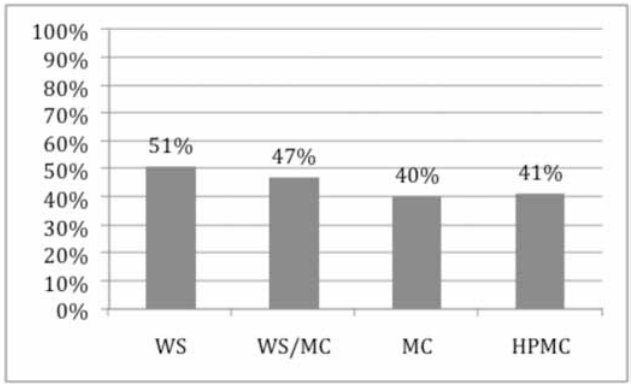

Figure 3: optical density of samples after lining with lens tissue and flattening between mountcard, expressed as a percentage of the before-lining figure.

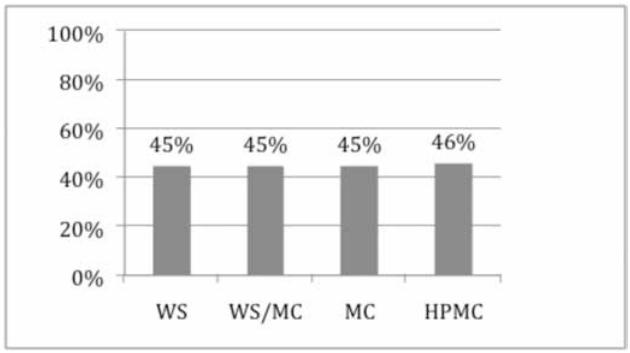

Figure 4: optical density of samples after lining with lens tissue and flattening between felts, expressed as a percentage of the before-lining figure.

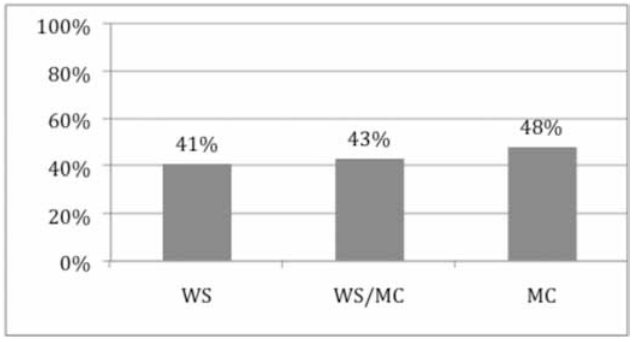

Figure 5: optical density of samples after lining with lens tissue and left to dry on a plexiglas® screen, expressed as a percentage of the before-lining figure.

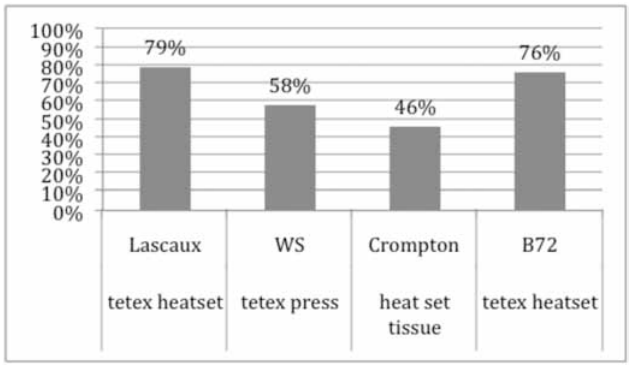

Figure 6: optical density of samples after lining with heat set or fabric linings, expressed as a percentage of the before-lining figure.

Figure 7: The lined side of the book papers and paper samples. From left to right: Tetex® applied as heat set with Lascaux® adhesive, Tetex® applied with wheat starch paste, Lens tissue applied with the mixture of wheat starch and methylcellulose, pressed between felts and Plexiglas®, Japanese tissue applied with the mixture of methylcellulose and wheat starch paste, pressed between felts and Plexiglas®, Japanese tissue applied with the mixture of methylcellulose and wheat starch paste and pressed between mountboards.

DISCUSSION

Optical density readings taken from grey sample areas after lining were found to be quite misleading. The Japanese tissue appears to the eye more opaque and more obscuring of detail than the lens tissue, yet many densitometer readings indicate less change in optical density with the Japanese tissue than with lens tissue (see Figures 1 and 4). This is likely due to the opacity and optical density of the Japanese tissue itself, which gives a reading of 0.07-0.09 against the plain white office paper background, equal to that of many of the grey readings themselves. The Japanese tissue is handmade, it is not nearly as consistent as the lens tissue in thickness and therefore transparency.

The text from the book papers was found to be clearly readable with all of the materials and methods tested. The clarity of the letters did vary, relative to the densitometer-tested ink samples.

Support materials

As expected, when assessed visually and supported by the optical density results (see Figure 1) the lens tissue was found to be significantly more transparent, and less obscuring of detail than the Japanese tissue Tetex® was superior in transparency to both of the tissues but its use in paper conservation is untested. As illustrated by the graphs above, over black ink, Tetex® is by far the least obstructive lining material of those tested. A disadvantage of using Tetex® is that adhesives such as starch and the cellulose ethers do not bond to the polyester fibres themselves, but rather fill the interstices (Owen 1988). A tight press was required to achieve a reasonable bond and this does leave an impression on the paper.

The transparency of the lining produced by the use of the Crompton® heat-set was relatively poor compared to the other samples. The level of transparency was quite uneven over the tissue area, and was quite visually disruptive. Having heard of a method employed in overseas labs to reduce the visual impact of heat set tear repairs, ethanol was brushed over the tissue side after heat application, and allowed to penetrate through to the substrate. This does noticeably increase the transparency of the lining, but the result is still quite opaque and obscuring of detail.

Adhesive

All of the aqueous adhesives tested showed a degree of variation, but not a significant difference in visual clarity and transparency. Wheat starch, methylcellulose and mixtures of both had excellent adhesion and peel strength. HPMC had generally very poor adhesion with all of the flattening and drying methods. Tissue applied with HPMC did not adhere at all to the samples air dried against Plexiglas®.

In combination with the Tetex®, Paraloid B72® was found to be unsuitable when applied wet, and adhered to the paper very poorly. Methylcellulose and methylcellulose/wheat starch mixture had inadequate peel strength; the Tetex® could be removed with little effort. Wheat starch, admittedly applied quite thickly, resulted in a strong bond with adequate peel strength. Adhesion and peel strength was found to be excellent when applied as a heat-set with either adhesive. Gloss from the heat-set adhesives could effectively be reduced with toluene : ethanol (60 : 40) vapour.

Method of drying and pressing

Overall, pressing with the tissue side against Plexiglas® produced the most transparent results when assessed visually or with a densitometer.

There is a trade-off between a gloss finish and transparency. When either pressed or left to dry against a hard surface like Plexiglas®, the contact surface is very smooth and has a slight silky gloss, not unlike a glassine or a clay-coated, calendered paper. The resulting surface is not however distracting or reflective of light. The gloss is slightly uneven on some of the samples left to dry on the Plexiglas®, most likely through uneven adhesion. In some treatment situations, such as when lining heavily calendered papers, this may be the most appropriate treatment option. In others, such as textured porous papers, it may not be appropriate at all, and another technique such as pressing against felts would be more suitable.

CONCLUSION

In determining the level of transparency of support linings several things became apparent:

1. Among the support carriers used in the lining systems, the finest and thinnest, the lens tissue and the Tetex®, were, as expected, the most transparent;

2. Regarding the drying and pressing methods, it was found that pressing against a hard surface on the tissue side gives the greatest clarity for both printed text and areas of solid black and grey, while imparting some gloss;

3. Within the range of aqueous adhesives tested, even though some degrees of variation were detected, any adhesive was found to be significantly better in achieving image density and clarity;

4. Results from the heat-set systems were variable. The commercially made heat-set tissue performed fairly poorly, while the lab prepared heat-set textiles had excellent adhesion and transparency.

The support material used for lining has the greatest influence on the transparency of the process, but also on the strength and support imparted to the object. If transparency is required when lining, lens tissue or similar thin tissue should be preferred for double sided objects with minimal reduction in clarity of original material. If strength is a particular issue (eg. booklet material), Honmino or another thin Japanese tissue may be used, though

with some further reduction in clarity.

Pressing and flattening methods employed have a greater influence on tissue lining transparency than the adhesive used. Different methods may be used in order to achieve the level of transparency most appropriate for the object to be treated.

Tetex® or similar thin polyester fabrics are potentially excellent materials for lining, although further investigation into its compatibility with paper would need to be made before it could be considered for use in treatments.

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MATERIALS

Pelikan® black drawing ink.

Office paper.

Paperback book papers.

Barbieri Densy 521® combined reflection and transmission densitometer.

Crompton® Heat Set tissue.

Tetex, polyester fabric.

Crompton® lens tissue.

Honmino Japanese tissue.

Silver star® wheat starch.

Methylcellulose, low substitution, BDH Chemicals Australia.

Hydroxypropyl methylcellulose, Aldrich Chemical Company.

Paraloid® B-72 acrylic resin.

Lascaux 360® and Lascaux 498® acrylic polymers.

ACKNOWLEDGEMENTS

Bernard Kertesz, Kerry McInnis & Cathy Challenor.

BIOGRAPHY

Nick Zihrul has a background in fine arts, and graduated from University of Melbourne in 2007 with a Masters in Cultural Materials Conservation. He has worked with the State Library of Victoria, The Cunningham Dax Collection, Preservation Australia and Strand Art Conservation. He has been working as a paper conservator for the Australian War Memorial since 2008.

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