This paper catalogues major changes in attitude during conservation practice for the treatment of degraded paintings on canvas. Current practice at Tate. Changing aims and ethics of conservation provide challenges and opportunities: the key to progress lies in a better understanding of the structural mechanics and degradation processes of stretched canvas paintings.

The structural treatment of deteriorated oil paintings on canvas is a major concern of painting conservators. In the past, the attachment of a second canvas to reinforce the weakened original was universal. This was called re-lining and later became known as lining. But in recent years the value of lining has been questioned and its disadvantages documented. A major change of opinion has occurred, reflecting modern attitudes to conservation which place greater emphasis on preserving the original state of canvas support and applied paint film. These attitudes in part derive from recent academic preparation conservators now receive. This has largely replaced apprenticeship training, which tended to dependant on the accuracy and relevance of engineering models derived. The application of this knowledge to conservation practice creates an ongoing dialogue about aesthetics and ethics of conservation.
The 1974 Comparative Lining Conference

In 2004 the UKIC held a meeting on the subject of ‘Alternatives to Lining’ to mark the belated publication of the often referred to papers from the Greenwich Comparative Lining Conference in 1974. These two events were an opportunity to take stock of changes in conservation practice for the structural conservation of canvas paintings. This paper presents an overview of the subject and is illustrated by some examples of solutions to structural problems that have been used regularly.

The Greenwich Conference was a very significant event since it was the first time the subject. It brought together a group of specialists from around the world to discuss what was required from a lining. There was little meeting of minds on solutions, but the full range of problems was at least identified. In retrospect it was clear that our understanding of linings was inadequate.

After the conference, since there had been no agreement on what constituted a good lining, Prescott, co-ordinator of the conference, called for a moratorium on lining to give conservators a chance to take stock of the situation. This was not what I wanted to hear and it took me some time to see that he had identified a hugely important issue in conservation that needed solving. My initial response was to find out more and to experiment with all the options presented. But in museums, we are able to defer lining because we know that paintings will be kept in acceptable condition and will be available for re-examination, which allows us to reconsider our treatment if it continues to cause problems. This is not entirely true but in a museum the argument for carrying out a lining is stronger.

Lining was seen as a solution but the criteria for lining had never been clearly stated. There was much confusion between the need to provide a sound support film to the original canvas. What is a sound support? One that copes with the effects of humidity and temperature changes, is chemically stable and visually acceptable. A more subtle solution? What about more subtle solutions? It was clear that to provide a sound support, but that is an extreme solution. What about more subtle solutions? It was clear that more subtle solutions were needed to know much more about the painting and the conditions to which it would be exposed.

No-one had addressed the most fundamental questions. What is happening within the structural body of a painting? What forces exist within the layers of a painting on canvas? How do they act? What are their consequences? We knew that when a wood panel is constrained by a lining, these forces are transferred to the lining and this can cause problems. But we didn’t know how much and we didn’t know how to measure it. This is where the Greenwich Conference was very significant.
forces that can crack it from end to end. We knew that when rabbit-sk glass from inside of a beaker. We knew that pre-stretching can cause conditions paintings become very brittle and can cause paint to flake. canvases can contract, sometimes dramatically losing areas of paint. We knew that with heat and pressure we can distort seemingly solid plastic control the application to everyone’s disadvantage.

**Whether to line**

![Fig.1](image)

Thomas Gainsborough
*An Old Horse* c.1755 detail
(raking light photograph)
oil on canvas, Tate.

This is an example of a painting that has suffered damage during a glue lining.
The canvas texture is reinforced into the surface of the paint and the brush strokes have lost their crispness.

© Tate

By examining many examples of glue lined paintings and their conser results of glue lining, particularly in the United Kingdom, had been dis squashed, the canvas texture re-inforced in the paint and the precious...
were forever lost (fig.2). By contrast, the setbacks from modern lining course, we are all personally responsible for the effects of the linings

Fig.2
W. R. Sickert
Tipperary 1914
Oil on canvas (detail), Tate
On an unlined painting we may appreciate the spontaneity of an artist's brushstrokes, the nature of the paint:
© Estate of Walter R. Sickert

Responsibility is the key issue. In the past, the lining process was car were often employed by restorers, who in turn were responsible to the owner. Was the continued insensitivity to lining damage caused by thi simply that damage was thought to be acceptable as an inevitable sic from falling apart? As I saw more old glue linings it became clear that Morrill continued to cause the same kind of damage over and over ag by museums, which were prepared to send more paintings to be lined.

Interestingly, our recent studies of some nineteenth-century artists' te such as William Holman Hunt, Ford Madox Brown, Sir John Everett M getting their canvases lined very early or even during the painting pro flattening and weave re-enforcement and we suspect that in some ca
to take on the characteristics of the lined old masters that they had se

In the past our attitudes to physical and structural threats to a painting limitations of our own imaginations. We may imagine that our treatme range of unpredictable problems. In this case we are likely to go too f. may imagine that we must not contaminate our painting with unnec prevent deterioration. The key is to have an accurate model of the fut consequences of an intervention.

**Understanding the problem**

Since Greenwich we have made much progress in understanding how how it responds to its environment and to our actions. Paul Ackroyd h changes in lining practice. In particular, careful measurements of the materials have been carried out by Mecklenburg, Hedley and Michals

Conservators began to understand that not only the canvas and sizing moisture very significantly, if slowly, and that the moisture content influ the paint, making it more susceptible to the effects of heat and pressu We could soften some paints but not usually the lead whites. Glue pa heat and moisture exploit this moisture response whereas linings usur been invented more recently to avoid it. But glue linings are more eff cracks, not simply holding them tightly in plane. Oil paint moisture res damage has been done by glue liners in the past. With enough heat a into all sorts of interesting shapes.

Mecklenburg revolutionised our view of the canvas as support by sho painting carried much of the load (fig.3). The ground and paint laye load, and the relationships between the layers changed with the chan painting aged and cracked the forces became disrupted in the paintin cracks and cupped paint. We could now begin to appreciate why glue down raised cracks, whereas other methods were not. The persistenc at least seemed rational. Could we learn from their success in flatteni consequences inherent in their approach?
Thanks to Hedley, shrinkers are no longer a mystery. Conservators understand the behaviour of the glue layer sitting as a separate layer on top of the canvas because it was applied cold by a colourman such as Roberson. Above 75–80%, and animal glue loses its strength. Tightly woven Ulster linens were not as solid and dependable as previously thought. We looked with new respect at the flimsy open weave French painters of the twentieth century.

More recently work by Young and colleagues has continued to develop our understanding, filling in detail about internal and external forces, generating computer models of how a painting behaves, and beginning to measure the effects of specific conservation treatments. Moving a painting onto stiffer fabrics that match the glue for load carrying? We are still using the same specific sailcloth that Hedley found at the Earl’s Court Boat Show in 1981.¹³

The realisation that a lining canvas is only one of several important components of a painting has changed our frame of reference. Separating the consolidation process from the lining was a crucial change in thinking.¹⁴ If each process has to be justified separately, the arguments in favour of carrying out a lining are rare. That has been possible to investigate the effects of moisture treatments, adhesives and treatments in isolation from lining. Indeed, we have been able to show
disadvantages of lining: weave emphasis, excessive flattening, the moomoating without attaching a second canvas.

Strip-lining

Given that in the past we understood very little about the complexities even now we do not understand everything, the practice adopted by really intervene as little as possible. But when a canvas is around a hundred familiar signs of deterioration, we need to intervene.

Often the tacking edges are more damaged than the bulk of the canvas because of the effects of tacks and resinous wood. We rarely remove a canvas from its stretcher. When we do, we risk damaging the tacking edges, which may not be is then that we resort to strip-lining, the application of a strip of canvas: (fig.4.15

Strip-lining is often done with polyester canvas and BEVA adhesive (© Tate

Fig.4
A 150 year-old primed canvas which has never been painted displays all the basic deterioration characteristic
flexible and provides good adhesion. It is heat sealed at 65 degrees c of how far to extend the strip lining into the picture plane. It must be fa weak edges. Deformation in plane at the strip-lining edge is much les flexible ethylene vinyl acetate.

Strip-lining has largely replaced lining since it begins to address many put the painting in the category to be lined.

Tears

Tears are often cited as the reason for lining and indeed major tears e or more need extra support. But most small or medium tears can freq involve lining. The canvas is not normally removed from its stretcher. using a brush or swab to shrink the extended yarns back into plane so the tear this is usually possible to achieve but if serious distortion has some canvas yarns. The areas most resilient to treatment are distortion maximum stress concentration has occurred. Placing the canvas loca heated spatula and moist blotting paper can usually achieve a reason repaired either by using adhesive or by sewing. Some recent papers l and made useful observations on best practice. The essential points are the plane and level of the canvas and the immediate area of the tear, joint, with the yarns aligned. Next, the lost paint is filled and retouch and the most extensive part of the retouching intervention is in disgu has occurred around the tear.

Flaking paint

Lining a canvas was once thought to be a valid treatment to consolflaking is caused by poor adhesion between the ground and canvas. t technique, flaking can occur between paint films. As with other aspec difficult type to deal with, but fortunately relatively rare.

However, the usual problem is the need to re-attach an original lean v Because the dimensions and mass of each lifting and potentially flaking Newton’s law tells us that the forces needed to re-attach them are ve
raised edges of paint that have escaped the conservator’s attention remain very stable for having been exposed to constant handling and display. The demands we know even wax/resin is enough to hold an isolated area of paint. One of adhesives has been suggested for consolidation and lining and not on the best one.

Perhaps the best adhesive is the most stable one. In conservation the truly reversible adhesive or consolidant is by definition not possible.

Our model of a canvas painting tells us that the canvas tension may be carried primarily by the ground, depending on the humidity, except at discontinuities (cracks) where the load is entirely on the canvas. This is a mechanism that leads to cupping and flaking of paint/ground. Canadian Conservation Institute suggests that drying of the paint layers may counteract cupping, an adhesive with an elastic modulus at least as high as needed. Such a structural adhesive would not be removable. We need re-attach the canvas or be much more ambitious and reverse some of the effects of cracking. The approach still needs much more research and is I think the outstanding issue yet to be addressed.

If we accept this limited objective I think we should not worry too much about the nature of the adhesive – after all it has to form a bond to dried oil, pigment, canvas and rabbit-skin glue, very diverse materials. This diversity of surface energy is part of the reason the original paint failed. The adhesive needs to have broad properties. That is why various commentators have justified using adhesives from fish glue through synthetic emulsions to waxes.

**Prevention**

Much of a museum collection of contemporary art should be in good condition but we can be certain that it will deteriorate in a similar way to existing works in the historic collection. Stretched canvas to paint on and oil priming has only very recently been replaced by acrylic. Differences in degree but the structures remain similar. However we can predict that when contemporary works eventually need to be treated future conservators will have serious or insurmountable problems. We should therefore take action now to prevent or retard deterioration.

Most museums put much emphasis on preventive measures, reducing
and storage. This has been the mainstay of the approach at Tate. By protection of works of art and restricting direct access to works of art. By improving gallery environmental conditions and air quality we can avoid much acc

Framing policy has proved extremely effective in the past 30 years. By strengthening of frames to ensure rigidity and the application of low reflectivity glass when ever possible provides effective mechanical protection and ensures a microclimate that is more stable than the best air-conditioning system. The extensive use of carrying/transit frames, wrapped in polythene, for handling, storage and lorry transport is also a mainstay particular when our collection is used so heavily.

We also prioritise the examination and treatment of newly acquired works that pre-empts some of the deterioration effects that we predict. By surveying the collection we have identified those works already in the collection that need treatment. In the past many of these works have been prime candidates for lining but now we look for alternatives.

**Double canvases (loose-lining)**

In the nineteenth century several London colourmen sold double canvases: Holborn and later, Robersons and Winsor and Newton. Double canvases were regarded as a commercial product and were bought by major artists. Many later paintings by J.M.W. Turner, W.P. Frith, Sir W.P. Frith, Sir Edwin Landseer W.Holman Hunt also used double canvases.

These double canvases normally consist of a tightly woven heavy Ulster linen canvas, sized with glue and primed with a lean oil ground. The ground is usually pigmented a dull white using a mixture of white and chalk applied by brush in at least two layers. It is applied evenly and smoothly, as expected from a commercial product. Large pieces of stretched canvas are used in single and double canvas systems.

When the ground has dried, the first canvas is stretched on a substantial expandable wooden stretcher with the ground facing the stretcher. Zinc coated iron tacks are normally used. The second canvas is stretched on the same stretcher, this time in the conventional way with the front, again using tacks. This became the primary canvas for painting on. The intention was to create a sandwich structure of ground, sized canvas, sized canvas, and ground.
two canvases, which are simply held together by the stretching proce
A variation on this method was the use of an un-primed canvas behin
one. This was cheaper and no doubt not considered as good.
Examination of the primed double canvases in the late twentieth cent
old revealed that the auxiliary canvas grounds had cracked with an al
painted canvas ground (fig.4). They had cracked extensively to form a
cracks, which had then opened and allowed the paint to cup. The mo
linen and the thickness of the ground were the chief contributions to th

Fig.5
A conservator attaches a strip-lining to the edges of a canvas
© Tate
When these supports were dismantled, removal of the primary canvas
of dust and appeared to be relatively well preserved. Similarly, the au
this was an effective system of preserving the canvas from the effects of pollution, both particulate and gaseous, which was principally sulphur dioxide in the period in question.

However this double canvas system (sometimes called an original loose-lining) did not prevent cupping of the ground and paint, nor did it prevent corner draws and loss of tension. Many of the canvases were relined in the 1960s, usually in an attempt to flatten disturbing cupping and undulations. Auxiliary canvases were very useful objects on which to practise the flattening process.

The valuable experience of one hundred and fifty years of aging revealed to conservators at Tate to use modern loose-linings on more recently painted works, as a preventive measure and also for older paintings that we did not wish to line. The barrier effect against dirt and pollution was clear but their failure to prevent the effects of canvas relaxation was evident. Rather than use linen canvas for modern loose-linings we chose polyester material; it is a fine, even polyester yarn which has been tightly woven, then heat treated to form a tight canvas and lock the weave in place. When used as a sail it is designed to be impervious to water and it therefore it can significantly reduce the transport of air to the canvas reverse and thereby reduce the effects of most gaseous pollution. The material is not expected to relax or creep. It acts to keep the stretcher in plane. I have a polyester canvas that I stretched twenty five years ago and it is still very tight. It ought to provide an excellent support.

When a painted canvas is stretched on top of a polyester loose-lining it will not need to be stretched so tightly. It will look and feel tight even though only a small force is exerted. This is a very important effect, which prevents, or at least reduces, the long-term relaxation that would otherwise occur with a tightly stretched linen canvas, even though this may not manifest itself until fifty years.

One drawback with a polyester loose-lining is that the reverse of the canvas becomes invisible once the polyester may even be taken for the original. If further work needs to be done to a painting a polyester loose-lining may need to be removed. An advantage is that the original stretcher can be preserved by this system and the total weight is only increased a very small amount.

A rigid support

When the stretcher is inadequate, as with many large modern works, the conservator may devise an entirely new support system that offers rigidity.
museum the extra weight is not such a problem and can even be an advantage. But replacing with a more rigid structure is a major aesthetic intervention, changing everyone agrees with such a change, although I would argue that it is from the front when the painting is on display.

A rigid support can be constructed from an aluminium honeycomb panel manufacture. These are typically 25 mm or 50 mm thick, very light and the honeycomb at the edges a shaped piece of softwood can be inserted edge that can take tacks or staples. It is then possible to stretch a canvas over a stretcher. Like a loose-lining the panel provides support and allows of paper is usually attached to the front of the panel to isolate it from the provide friction. Being completely impermeable to moisture, the panel between it and the canvas. Being rigid, it provides a stable tension and reverse. Physically, it is the ideal support and readily reversible.

There are limits to the dimensions of individual panels but they can be joined indefinitely to make panels. Very large panels are heavy and difficult to lift unless handles out, but I think this is a fairly minor limitation, since it is possible to stretch keying out. If the canvas has not been stretched enough it should be In future if there is relaxation of the canvas it can also be re-stretched minimum by the original low tension and the absence of repeated key the appearance of the canvas painting from the reverse and changes

**Blind stretchers**

Blind stretchers with panels inserted between the members have a history. Some of these objects are beautifully constructed and they combine the panel. But they do not appear to prevent cracking and the repeated keying cracking and corner draws.

**Stretcher bar lining**

Many paintings are wanted for exhibition and loan. They need to travel exposed to different environmental conditions. A technique devised a (previously known as a cami-lining in some literature). This involve
support, but in this case attaching the polyester to the reverse of the stretcher and feeding the polyester under the stretched canvas. Tensioning the stretcher in this way produces a tensioned structure in which the lining is in contact or near contact with the outside members and feeding the polyester under the canvas. Tensioning the stretcher in this way produces a very rigid structure and needs to be careful not to pull too hard and remove or distort the tension.

The main value of this technique may not be immediately apparent but becomes clear. Most old cracked paintings have cracks corresponding to the flapping of the canvas against the stretcher. Loss of tension may play a role in this cracking as does the hygroscopic effect of the stretcher. But when a painting is subject to repeated forced vibrations at a level and frequency that is in a range of 10–20 Hertz. By preventing any movement at the middle of the painting the natural frequency is raised to about four times its original frequency, usually clear of the main input from a vehicle. The bar lining is applied continuously across the back of the canvas and the trapped air absorbs the energy of vibration. The effect needs to be seen to be believed.

A great advantage of the stretcher bar lining is the speed with which it can be applied (fig.6). With practice it can be done in fifteen minutes and removed in five, depending on the number of staples. It is entirely reversible and preserves all aspects of the original stretching. We use it on many canvases to make them suitable for loan and transport and it normally remains in place for the next time the painting is moved.

**De-lining**

Removing an old glue lining is not without its risks and is very time consuming. We do it very infrequently, not least because it begs the question, what should we replace it with? If we consider that the lining was not necessary then the prospect of returning the painting to an unlined state is enticing, but it may be difficult to assess just how good a state the original canvas is in.
For paintings that have suffered serious lining damage in the past we might like the idea of reversing the damage. We can take off an old lining but it is unlikely that we can repair flattened impasto or emphasised canvas weave. If that it has become part of the object’s history. If the lining tacking edg the canvas and glue for about 25mm width around the perimeter of th lined painting.

**De-acidification**

Most of the treatments discussed so far are physical interventions, but deterioration of cellulose is predominantly a chemical process. By air and in the dark it is hydrolysed by water vapour. The oxidation of the pH of the canvas creating ideal conditions for hydrolysis. Air pollution early attempts to reduce oxidation with anti-oxidants were not succes materials to increase pH was very successful, drastically reducing the rate of deterioration of new canvas when excluded from light by an or argument for its application to all new canvases.

We have been tentatively de-acidifying canvases now for about twenty surmountable disadvantages to this procedure. Several studies ha unwanted side effects, but as time goes by I am increasingly confider others. In careful hands, the application of a de-acidification agent (methoxy methylcarbonate in a volatile solvent) appears to be effective rate of deterioration of new canvas when excluded from light by an or argument for its application to all new canvases.

Older canvases are frequently degraded and have absorbed much su Certain fibres such as hemp and sisal deteriorate very rapidly and be measurements between 3 and 4 are common. These canvases should rapid decay. Leaving an alkaline reserve of magnesium ions can prov process accelerates again.

We are also beginning to go back to the oxidation problem. We are ci art on paper that will be air-tight and will allow us to exclude oxygen. l to some painting canvases.
Conclusion

Now that paintings are rarely lined it is difficult for a conservator to obtain practical experience with different types of lining. This means that the current generation may have to make decisions based on studies of the past, which may not give enough information to establish a balanced account of the advantages and disadvantages. Practical studies are likely to include the perceptions and pre-occupations of conservators reporting on their work. Detached scientific studies of lining processes may not take into account the full nature and range of the paintings that are under consideration. It is important to review all the literature and not to come to conclusions too quickly about one solution or another, leaving room for a range of possibilities for action.

Conservators have only a few reliable solutions to the complex structural problems that occur on canvas. In the past we have responded too late and too heavy-handedly to structural damage, sometimes creating more problems than we have solved. In the last thirty years we have seen a radical improvement in our understanding and have adopted methods that are far more considered and less invasive.

Improved understanding of paintings on canvas has given us new ways of approaching any treatment, but it does not prevent the need for ethical decisions. We can define a number of hierarchies: the degree of intervention that is considered appropriate for a treatment and the seriousness of any negative side effects. These are dependent on the use to which the painting is to be put and the environment to which it will be exposed.

In general, we should like to preserve the nature of the object, the artists' techniques and the technology, but we need to make sure that the painted image is presented well and that the painting is displayed, loaned and stored safely. We do not want to have to return to the under-bound condition of skilful but unthinking practice to one of much better knowledge.

As a result of this new knowledge in some areas we need to reconsider our ethics, many of
superseded by events. More subtle solutions are now available and we can analyse the forces involved. But our solutions are only as good as the accuracy of our predictions. In particular, to intervene chemically and the implication that this is best done while it challenges the simple notion of minimalism.

28.

1. Stephen Hackney, ‘Reline, Line, Deline’, in Mary Bustin and Ton

Structural Treatment of Paintings on Canvas without Lining, UKI


11. Marion Mecklenburg, ‘some Aspects of the Mechanical Behaviour


Stephen Hackney, ‘Framing for Conservation at the Tate Gallery’, pp.44–52.


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