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title: Customized Methodologies Developed to Solve Conservation Issues with Large-Size Paintings on Canvas

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abstract: This paper describes some customized methodologies developed to solve certain complex problems on a large-size painting on canvas by Alessandro Allori, which was restored from 2008 to 2009 at Laboratorio degli Angeli in Bologna, for the exhibition *Ferdinando I de’ Medici: Maiestate tantum* at the Medici Chapels in Florence. These methods are used to illustrate the authors’ own approach to complex structural problems.

short\_title: Customized Methodologies to Solve Conservation Issues with Large-Size Paintings on Canvas

# <A-head> Introduction

“We are firmly convinced that there cannot be a single method valid for every painting—not only for obvious reasons related to the nature of the work, but above all because of the individual ‘character’ of the painting, with its ‘own’ fabric, its ‘own’ ground preparation, its ‘own’ pigment and its ‘own’ reaction to the passage of time. It follows that if there is no single method and no single material appropriate to every picture, it must and will be for the painting itself to impose a careful choice between the various methods and materials” ({{Baldini and Taiti 2003|, 115}}).

The quotation above is an excerpt from Sergio Taiti and Umberto Baldini’s address at the Greenwich lining conference in 1974. Sergio Taiti had been chief conservator for structural treatments on canvas at Opificio delle Pietre Dure of Florence for about twenty years and during his tenure he distinguished himself for having a deep sensitivity toward the specific characteristics of paintings. We didn’t have the opportunity to meet him in person, but we had our training in canvas conservation with Luciano Sostegni, who worked closely with him for a long time and became his successor at the Fortezza da Basso’s Laboratories. Although our profession led us to test and use new and different materials and methods, his teachings remain the basis for our approach to work and we are still firmly convinced of their validity.

We believe that preliminary study of a painting, in order to deeply understand its materials and technique as well as its present condition, is essential to define customized treatments for conservation. From this point of view, we try not to focus on only a single material or methodology; instead, during the preliminary decision-making phase, we usually take into account a wide range of possibilities. By doing so, we allow ourselves the chance to decide to employ different materials in different ways.

Moreover, we consider the minimal intervention approach as our guide, but we believe that some clarification about this matter is needed. We think that the *minimum* should definitely be calibrated to the specific needs of the artwork, in order to solve its conservation problems, slow its degradation process, and try to avoid further treatments in the near future. If keeping the treatment to a minimum means minimizing the impact of conservation on the artwork, we should consider only treatments that actually solve the identified problems. For example, neglecting to guarantee the color or the priming layers’ adhesion to the original support effectively might lead the painting to undergo another conservation treatment within a short time, and this will probably result in a more stressful and invasive practice in the end. At this point, can we say that we have kept our treatment to the minimum needed, or should we admit that what we have done is not enough appropriate to the conservation needs of that individual artwork?

For a decade we have adopted and promoted a diagnostic protocol[[1]](#endnote-1) aimed at defining a more accurate and objective situation to provide additional information to help the conservator (with his own experience) in choosing a more appropriate methodology, specifically suited to the artwork’s structural conservation conditions.

# <A-head> Issues with the Painting

The painting by Allesandro Allori represents the *Allegory with the Triumph of Florence* and measures about thirty square meters. It was created in 1588–89 to celebrate the marriage of Ferdinando I, grand duke of Tuscany, to Christine of Lorraine, and was located outdoors, above the arch of the Florentine Porta al Prato. The scene was painted with a leanly bound oil, applied in thin and even layers. The fine linen canvas was made of four pieces, whose selvages were positioned horizontally and sewn together. The support was prepared with a thin, light gray ground, probably using animal glue and a little linseed oil as a binder.

When we first examined the painting, it was in storage at the Pitti Palace. The canvas was mounted on a three-part folding wooden stretcher ([**fig. 11.1**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/fig-11-1)), probably provided after the canvas was lined with a glue-paste adhesive in the early part of the twentieth century. The painting suffered new damage during the flood of Florence in 1966: it was partially impregnated with water, mud, and naphtha (which had leaked from buildings’ heating systems and was carried by the flood water), and diffused biological growth developed. Repeated handling of the folded painting over time had led to the permanent deformation of the original canvas along the perimeter, resulting in a 15-cm extension at the edges compared to the middle area of the support width. The old lining adhesion was compromised, with evident and diffused blistering. Over two hundred new tears, cuts, and holes weakened the canvas and some patches had been glued to the back of the lining, using animal glue or wax-resin.

Thick mud residues, molds, and patches were also visible on the front. The original seams appeared partially ripped and deformed, and extensive fillings and retouching on the paint layers were mostly applied on these areas.[[2]](#endnote-2) The painting had been folded with the painted side face in. and this led to the detachment and loss of thousands of paint fragments. After the flood, an attempt to fix unstable paint layers was carried out using wax. This led to the complete waterproofing of some localized areas, especially around the seams joining the pieces of the original canvas.

The main problems to solve were reducing the huge deformations of the canvas, restoring the compromised structural integrity of the support, providing a good adhesion between the paint layers and the original canvas and, finally, the evaluation of the ability of the support to undergo a new tensioning on the stretcher, considering its large size and significant weight.

# <A-head> Conservation Treatment

To define the methodological choices and the materials to use, compatibility with the original materials, use of minimum amounts of new materials, and future reversibility were all considered. Since full reversibility of binding agents for consolidation or adhesives that impregnate the paint layers is often impossible, it was important to us to leave open the possibility to use a wide range of materials in the future.

Three main operating activities to reflect on were identified: the facing, the re‑adhesion of the paint layers to the support, and the lining.[[3]](#endnote-3) These three phases are clearly separate, even if strongly interconnected, especially with regard to facing and consolidation. This is due not only to the need for compatibility with the painting materials, but above all for the intimate connection taking place during the intervention. Treating the canvas from the back with an adhesive to fix flaking paint layers will probably lead to the impregnation of the faced surface. It is then crucial to consider products with similar properties and solubility—or at least to evaluate the possible interactions of materials. This is important to ensure the correct and easy removal of the facing. For that reason, theoretical considerations were thought over and tests were run to select the best material to solve the specific problems mentioned above.

In order to facilitate the flattening of the canvas and to be sure of safeguarding the appearance of the lean oil technique, an aqueous method was preferred and adhesives like extra-fine rabbit skin glue and Aquazol were tested.[[4]](#endnote-4)

Before facing the surface, dust and mud residue were carefully removed using soft brushes and swabs with deionized water. Some local preventive fixing was needed to avoid color losses. Old fills and retouching were eliminated, mold was removed, and the areas affected were disinfected.

During the surface facing, a first flattening of the canvas’s deformation was possible, thanks to the moisture added by the aqueous adhesive and to some light tensioning provided by the contraction of Japanese paper while drying ([**fig. 11.2**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/fig-11-2)).[[5]](#endnote-5)

Using a polystyrene roller, the painting was then turned facedown to work on the back and remove the old lining adhered with glue-paste.[[6]](#endnote-6) The residue of the old glue-paste was carefully removed with a scalpel. In some problematic areas where the adhesive was particularly tough, an agar gel[[7]](#endnote-7) was used to swell and soften it, making removal easier.

All cuts were brought back to the correct position with the aid of tension, applied using tie-beams adjusted by rubber bands ([**fig. 11.3**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/fig-11-3)), and moisture, released through a Gore-Tex fabric. Polyester fabric tie-beams were adhered to the back of the canvas with original formula Beva 371 film. The humidification, tension, and time needed were related to the extent of deformation being treated. A polyester thread was used to resew the selvages where necessary, passing through the holes of the original seam, when possible.

Many cycles of humidification and tension were needed to flatten the canvas. Due to the very large size of the painting, stretching it on a temporary loom was deemed expensive and impractical, so it was decided to tension it on a thin worktop placed directly on the floor. To do this, strips of polyester canvas[[8]](#endnote-8) were fixed to the perimeter with Beva 371 film, reactivated at two different times: the first on the polyester canvas, at 80°C, and the second, on the back of the original canvas, at 65°C. This particular procedure is intended to create a stronger bond between the adhesive and the polyester canvas than between the adhesive and the original canvas, ensuring better reversibility in the future. Ideally, no adhesive will be left on the original canvas when the strips are removed; at worst, only a few traces will remain.

A complex problem we needed to solve was recovering the adhesion of paint layers that had been treated with wax or impregnated with nonpolar substances in the past, using an aqueous adhesive. This was preferred to help the flattening of the original canvas and to guarantee the easy removal of the facing. Tests were performed to evaluate the strength of the bond produced by extra-fine rabbit skin glue, sturgeon glue and Aquazol 500 and 200 dissolved in water, ethanol, and acetone. Aquazol 500 in acetone showed good adhesion properties on wax samples.[[9]](#endnote-9)

To adhere the paint layers to the original canvas, two coats of Aquazol 500 were applied at two distinct times. First, Aquazol 500 in acetone at 10%[[10]](#endnote-10) was applied to guarantee good adhesion of the areas that presented wax and nonpolar substances. Later, a second application of the same resin dissolved at 5% in a solution of acetone and water (1:1) was used to effectively increase the flattening of the canvas.

After the complete evaporation of solvents, always keeping the painting tensioned,[[11]](#endnote-11) the thermoplastic adhesive was reactivated by heat in a vacuum bag (envelope). Heat was transferred to the adhesive using water at a predetermined temperature, provided by a movable temporary “tub.” The materials needed to carry out this intervention are shown in [**fig. 11.4**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/fig-11-4). The painting was placed facedown in a vacuum bag made of silicone-coated polyester film (Melinex). On the top of this bag, a tub made of a Melinex sheet placed in a wooden loom[[12]](#endnote-12) was prepared. A certain volume of water, preheated to a predetermined temperature, was poured into the tub. After ten minutes,[[13]](#endnote-13) the water was removed, and the tub was shifted to treat another area. This operation was repeated to treat the whole surface, always keeping the painting under pressure in the vacuum bag.[[14]](#endnote-14)

It’s important to underline that this method is not an alternative to the use of a hot table, but it permits heat transfer from the back also when working with the painting facedown is required.[[15]](#endnote-15) Using a vacuum system and applying heat through a tub containing pre-heated water guarantees that the whole surface is treated with the same pressure and temperature, substantially reducing the risk of nonhomogeneous performance of the thermoplastic adhesive.

In preparation for mending structural damages, some adhesives were tested ([**table 11.1**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/table-11-1)). To avoid damage to the original canvas in the future, the breaking point of the adhesive should be equal to or slightly less than the toughness value of the original yarn (see {{Orata 2009}}), measured by tension test with a dynamometer. The adhesive with a breaking point that is similar to that of the original yarn is highlighted in red in the table.

All the cuts, tears, and holes (more than two hundred) were mended thread by thread using Akeogard AT35[[16]](#endnote-16) applied with a tiny brush, using an optical visor. All the structural damages and the four seams were further reinforced by applying monofilament fabric patches adhered with a mixture made of 80% Plextol B500 and 20% Dispersion K360, reactivated by butyl acetate.

With the first steps of consolidation, tear mending, and humidification complete, we evaluated if lining was really necessary. A series of elements, such as the dimension of the canvas in relation to its ability to support itself, the presence of more than two hundred structural damages, the advanced degradation of the cellulose, and the presence of four horizontal seams, led us to the decision to apply an auxiliary support. As mentioned, every case is unique, and sometimes it is appropriate to assess the use of different methods and materials for lining.

Glue-paste lining did not seem suitable, not only because it would increase the weight of the whole structure, but also (mostly) due to the difficulty in maintaining the appearance of the painted surface, preventing the seams’ stitches from impressing on the front, and preserving the original seams. Lining with Beva 371 was also discarded due to the evaporation of a large amount of solvent (such as toluene) during the operation. Cold lining, using the Mehra system, was just as risky for the large amount of butyl acetate (or similar solvent) needed to reactivate Plextol.[[17]](#endnote-17) Using a thermoplastic adhesive in aqueous dispersion appeared to be a good solution to avoid the use of a fair amount of solvent, with its attendant risks of toxicity and fire.

A study focused on testing different adhesives obtained by mixing Plextol B500 and Dispersion K360,[[18]](#endnote-18) in different proportions, was carried out to obtain a final mixture to be reactivated by heating. Empirical tests were performed to define the approximate reactivation temperature and the reversibility of each mixture ({{Orata and Capellaro 2013}}|, 57–66) in order to identify the one that would better fit the features and conservative conditions of the painting ([**table 11.2**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/table-11-2)**)**. The possibility to match specific needs makes this acrylic-based class of adhesives very advantageous in devising innovative solutions.

Samples 1 and 2 are tests on the two pure resins (see [**table 11.2**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/table-11-2)). Each mixture was sprayed on a polyester canvas mock-up. After solvent evaporation, each was joined to a linen canvas mock-up in order to simulate the real conditions of use. The mock-ups were then placed in a vacuum bag and lined by increasing the temperature incrementally starting at 40°C going up to 80°C, applying a constant vacuum of 700 mbar. After each 10-degree increase, the bag was opened, each mock-up was tested, and the degree of adhesion was evaluated. Sample 4, composed of 30% Dispersion K360 and 70% Plextol B500, reactivated between 60°C and 70°C (shown in red in [**table 11.2**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/table-11-2)) was the one that showed a good combination of adhesion and reversibility.

This adhesive was sprayed on the stretched polyester canvas.[[19]](#endnote-19) Particular attention was paid to maintaining the correct tension of the lining canvas during the whole process. In fact, during the reactivation of the thermoplastic adhesive, the lining canvas was stretched again on the worktop to maintain the orthogonal orientation of the warp and weft threads and to avoid the transfer of undesirable tensions to the painting during the final stretching phase. If the lining canvas is not tensioned when applying the adhesive and when the lining is adhered to the original canvas, its threads will remain more extensible. When the lined painting is finally stretched on the definitive stretcher, more tension would be required to first stretch those loose threads, before transferring tension to the whole lined support. This excessive tension could result in damage to the original canvas, which is usually less elastic than the new lining canvas.[[20]](#endnote-20)

Before lining the painting facedown in the vacuum system, it was necessary to fill the biggest losses with stucco, to avoid the original canvas being pushed towards the paint surface, where paint layers were missing.

The adhesion of new canvas was carried out in a vacuum bag (envelope), with the painting placed facedown on a worktop. Nonwoven fabric[[21]](#endnote-21) was used as a cushioning layer, to preserve the thin brushstrokes, keeping the seams on the back at the same time. The adhesive was reactivated by placing 70°C water inside a loom and treating circumscribed areas of about 1 square meter using the tub system described earlier and outlined in [**fig. 11.4**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/fig-11-4). To stretch the canvas on the final expandable stretcher, the painting was positioned facedown to reduce the forces applied at the edges.

Not all the losses were filled and retouched, because the art historian who directed the conservation treatment chose to leave a historical memory of the flood of Florence. When the treatment was finished, the painting was exhibited at the Medici Chapels in Florence ([**fig. 11.5**](file:///Users/RBarth/Desktop/Finalized%20files-Conserving-Canvas--72122-to%20prep%20for%20TR/11-Lavorini/11-Lavorini_clean/fig-11-5)).

# <A-head> Conclusion

The methodologies described above are only some examples of solutions outlined to solve specific conservation issues on large-size paintings, but they represent the way we approach the work, focusing on the artwork, which always has its own requirements as a result of the properties of its original materials and subsequent history.

We believe that no best or worst methodology exists, but a specific and suited intervention should be applied based on a deep understanding of both the painting technique and the conservation history of the artwork. A protocol of scientific analysis helps to identify and quantify structural damages, and then to decide, together with the experience gained with practice, which conservation strategy is more appropriate to solve the specific problem, regardless of tradition, inclination, or current trends.

# <A-head> Acknowledgments

Thanks to Jennifer Ginevra (TEFL/Cambridge educator) and Dan Butcovich Pieroni (CELTA/Cambridge educator) for providing edits and revisions.

# <A-head> Notes

1. . Measuring the canvas pH, the degree of polymerization (DP), traction testing of the yarn (tensile strength) with a dynamometer, and eventual examination with scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS). See ({{Orata 2009|, 25–31}}). [↑](#endnote-ref-1)
2. The original support is made up of five pieces stitched together along the selvages. [↑](#endnote-ref-2)
3. Like every conservation treatment these phases are options and the restorer evaluates if it is really necessary to perform each one of them from time to time. [↑](#endnote-ref-3)
4. Both Aquazol 200 and 500 were tested. [↑](#endnote-ref-4)
5. Extra-fine rabbit skin glue produced by *Le Franc & Bourgeois* was used to face the painting layers with Japanese paper sheets (Tengujo kashmir 9 g/m2). The sheets fixed around the perimeter were glued to the worktop to prevent shrinkage while the glue dried. The high refining degree of this glue guarantees good elasticity and very light color, reducing the risk of color changes in a painting made with such a lean oil. [↑](#endnote-ref-5)
6. Florentine glue-paste adhesive is usually composed of wheat and rye flours, animal glue, water, Venetian turpentine, molasses and linseed mucilage. [↑](#endnote-ref-6)
7. 3% in water (w/v). [↑](#endnote-ref-7)
8. Trevira CS Delay, 100% polyester, 50 g/m2. [↑](#endnote-ref-8)
9. As suggested by Leonardo Borgioli, a chemist working at CTS Europe. [↑](#endnote-ref-9)
10. All solutions were prepared weight/volume. [↑](#endnote-ref-10)
11. Maintaining the canvas in tension is considered very important to fix the threads in a correct position, to reduce movement, and to give more stability to the whole painting in the future. [↑](#endnote-ref-11)
12. The tub usually measures about 1 square meter, which is an affordable dimension to easily handle a certain amount of water; 3 cm of water are needed to maintain temperature during the treatment. [↑](#endnote-ref-12)
13. Ten minutes was the minimum estimated time needed to guarantee that the adhesive reached the desired temperature. [↑](#endnote-ref-13)
14. This system was first performed by Sergio Taiti in the early 1980s. A video showing the tub system process should be available soon on the Getty Foundation website. [↑](#endnote-ref-14)
15. Working with the painting facedown—during both the adhesion of the paint layers and the lining—prevented the original seams from being pushed onto the paint layers, showing on the front, and thus compromising the artwork. [↑](#endnote-ref-15)
16. A polyurethane-based resin in water dispersion, manufactured by Syremont. [↑](#endnote-ref-16)
17. Mist-lining technique might have been a choice, but at the time we were not overly confident with it and the particular environmental conditions (very hot during the summer and without any climate control) would have required some adjustment. Moreover, the large size of the painting would have needed a considerable amount of solvent even using this method. [↑](#endnote-ref-17)
18. Plextol B500 is an aqueous dispersion of thermoplastic acrylic polymer based on methyl methacrylate and ethyl acrylate. Dispersion K360 is an aqueous dispersion of thermoplastic acrylic polymer based on 2-ethyl-hexyl-acrylate. According to technical data sheets, Plextol B500 and Dispersion K360 are miscible. [↑](#endnote-ref-18)
19. Trevira CS (Lipari), 100% polyester, 260 g/m2. The amount of dry resin left on the lining canvas was calculated at about 36 g/m2. [↑](#endnote-ref-19)
20. Elastic modulus is a measure of stiffness, defining the relationship between stress and strain in a material. The elastic modulus of the original canvas is usually quite different than the modulus of the new lining canvas. In our experience of tensioning new lining canvases, we have found that new canvas (whether made of natural or synthetic fibers) is usually more elastic than the original. [↑](#endnote-ref-20)
21. TNT 84: weight 105 g/m2, thickness 260 μm. [↑](#endnote-ref-21)