NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTAMENTO DE CONSERVAÇÃO E RESTAURO

LOUISA WITTORF

BSc in Conservation and Restoration

Exploring the Challenges of Glue-Paste Lining in a Humid Environment and the Ethical Considerations of Treatment and Retreatment

MESTRADO EM CONSERVAÇÃO E RESTAURO

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ABSTRACT

Glue-paste linings—traditionally composed of mixtures like flour and animal glue to attach a secondary canvas—have long been employed in painting conservation. However, these linings present significant challenges, including material degradation, invasive application methods, and adverse effects on the original artwork's aesthetics and structure. Over time, adhesive brittleness compromises the painting's stability, while the lining process can induce mechanical stresses that risk damaging original canvases and paint layers. Furthermore, chemical interactions between original and added materials may accelerate deterioration.

This dissertation explores alternative post-lining approaches that prioritize long-term stability, reversibility, and minimal intervention. Among these, mist-lining—a technique applying adhesive via a fine mist to create a nap-bond system—offers reduced adhesive use and eliminates the need for excessive heat and pressure. This method aligns with modern conservation ethics by minimizing invasiveness and enhancing removability, particularly suited for humid and warm climates.

Two Baroque paintings by Maltese artist Stefano Erardi—*Saint Thomas* and *Saint Andrew*—serve as case studies. In *Saint Thomas*, despite aesthetic concerns caused by lining seams, the painting's stability justified refraining from delining, underscoring a minimalistic, preservation-first ethic. Conversely, *Saint Andrew* exhibited significant structural damage due to lining degradation, prompting removal and replacement with mist-lining. This intervention protected the original paint, repaired structural issues, and adhered to conservation best practices.

Ultimately, this work demonstrates a shift in conservation from traditional glue-paste linings toward advanced, ethical techniques that safeguard the authenticity, appearance, and material integrity of historical artworks. These case studies illustrate how ethical considerations guide tailored conservation decisions, balancing necessary intervention with the imperative to preserve original materials and historical authenticity

1

INTRODUCTION

> "As soon as a picture is finished, it starts to deteriorate" – George L. Stout in *The Care of Pictures* (1948), Columbia University Press, New York

The conservation and restoration of easel paintings have undergone significant developments over the centuries, reflecting shifts in materials, techniques, and scientific approaches. Among these, glue-paste lining—a once-standard practice of attaching a secondary canvas to reinforce weakened originals—has been particularly scrutinized. This method, prevalent until the 1970s, came under critical review as conservators increasingly prioritized the preservation of original materials and minimal intervention in treatment processes. The growing awareness of the potential negative consequences of traditional glue-paste lining, particularly in humid environments, has necessitated a re-examination of its use in modern conservation.

Malta's specific environmental challenges, especially its high humidity, add complexity to the conservation of paintings, where glue-paste linings have historically been used. In such climates, the hygroscopic nature of the materials used in glue-paste linings—animal glue and flour—poses significant risks to the longevity and stability of these treatments. This dissertation explores the implications of glue-paste lining in humid environments, emphasizing its limitations and ethical considerations, and reviews alternative methods that have emerged in response to these challenges.

The objective of this work is twofold. First, it presents a comprehensive review of glue-paste lining and its alternatives, including both traditional and modern approaches. Secondly, it examines two case studies involving Baroque paintings from Malta, where different conservation strategies were applied to treat works lined with glue-paste. These case studies illustrate the decision-making processes involved in the treatment of paintings, weighing the structural and ethical challenges that arise in real-world scenarios.

The dissertation is structured as follows: Chapter 1 introduces the historical and technical context of glue-paste lining. Chapter 2 delves into the ethical considerations of this technique, while Chapter 3 discusses the conservational challenges associated with glue-paste linings. Finally, Chapter 4 presents two case studies, detailing the analysis, treatment proposals, and outcomes, thereby highlighting the practical application of the conservation methods discussed.

2

GLUE-PASTE-LINING

2.1 Historical Exploration of Glue-Paste Linings

In this chapter, the history of this traditional technique in the restoration of canvas paintings will be described, along with an overview of the commonly used ingredients and procedures of the lining with glue-paste.

2.1.1 History of Glue-Paste Lining

The origins of glue-paste lining can be traced to early lining techniques rooted in Italian and French traditions since the 17th century [Betancor et al., 2023; Conti, 2007; Garofalo et al., 2019; Soltan, 2010; Percival-Prescott, 2003]. Throughout history, the materials and techniques used in glue-paste lining have evolved in response to artistic trends, conservation challenges, and scientific advancements. In the 19th century, the principal reason for lining shifted towards preserving and protecting paintings from future physical deterioration [Young, Ackroyd, 2001; Yurovetskaya, 2023]. Lining was seen as a long-term protection measure [Ackroyd, 2002; Andersen, 2013]. Restoration manuals from the 19th and mid-20th centuries attest to the importance given to lining as a precautionary measure against environmental changes and potential damage [Ackroyd, 2002].

Traditionally, linen canvas served as the primary support for paintings, providing durability and versatility [Hackney, 2020; Soltan, 2010]. Over time, the choice of canvas material evolved, with hemp predominating until the end of the 18th century, followed by linen in the 19th century, and cotton towards the end of the 19th century [Hackney, 2020]. Linen, renowned for its strength and availability, became the preferred material for lining canvases due to its resilience and compatibility with adhesive applications [Hackney, 2020].

The adhesive used in glue-paste lining underwent several developments, reflecting advancements in material science and conservation practices. Initially derived from animal collagenic parts, such as bones or parchment, adhesives were prepared through hydrolysis and often combined with starch or flour mixtures [Soltan, 2010]. These adhesives, combined with pressure and heat, facilitated the adhesion process, strengthening the bond between the original canvas, the lining canvas, and the paint layers [Soltan, 2010].

The evolution of glue-paste lining mirrored broader shifts in conservation philosophy, with practitioners balancing the preservation of original artistic intent with the imperative to ensure the longevity of artworks [Ackroyd et al., 2001; Andersen, 2013]. As early as the 18th century, distinctions emerged

between restorers and liners, highlighting the specialized nature of lining techniques and the recognition of lining as a distinct aspect of art conservation [Cerasuolo, 2023].

By the late 18th century, glue-paste lining had become a routine practice, with little variation in methods and materials [Oberthaler, 2023]. Liners were trained in established techniques, and strict divisions between structural and artistic work were maintained. The liners were responsible for the structural work while the artistic work was carried out by art restorers [Oberthaler, 2023]. However, the 20th century witnessed a gradual shift towards a more preventive approach to lining, driven by a desire to protect paintings from future damage [Ackroyd, 2002; Andersen, 2013; Percival-Prescott, 2003]. This shift was underscored by the recognition of lining as a means to reinforce the structural integrity of paintings and mitigate the effects of environmental changes [Ackroyd, 2002; Andersen, 2013].

The legacy of glue-paste lining endures in contemporary conservation practices, albeit with notable adaptations and innovations. While traditional methods remained in practice until the 1990s, the exchange for synthetic adhesives marked a significant departure from centuries-old techniques [Betancor et al., 2023].

2.1.2 Ingredients of a Glue-Paste Lining

The foundation of glue-paste lining lies in the amalgamation of cereal flours and animal glues [Fuster-López et al., 2017]. These ingredients, readily available and deeply rooted in tradition, form the backbone of the adhesive medium [Fuster-López,Andersen et al., 2017]. Cereal flour, typically derived from wheat or rye, serves as a primary filler and adhesive thickener [Betancor et al., 2023]. Rich in starch and protein, wheat flour offers superior mechanical properties compared to its counterparts, contributing to the cohesion and viscosity of the paste [Rossi-Doria, 2023]. Rye flour, on the other hand, with its coarse and granular texture, functions as a bulking agent, particularly effective in enhancing bond performance for coarsely woven canvases [Ackroyd, 1996; Hackney, 2020].

Animal glues, derived from the gelatinous proteins of animal skins, provide the adhesive strength essential for bonding canvases [Andersen et al., 2017]. Traditionally rendered from mammalian skins, these glues, when combined with flour, create a cohesive mixture ideal for canvas preparation [Betancor et al., 2023].

Beyond the fundamental constituents of flour and animal glue, glue-paste linings encompass a myriad of additives aimed at enhancing performance and mitigating degradation risks [Andersen et al., 2017]. Among these additives, Venice turpentine emerges as a prominent plasticizer, derived from the resinous exudation of European larch trees [Ackroyd, 1996; Hackney, 2020]. When incorporated into the paste, Venice turpentine forms a colloidal suspension, imparting lubricating properties that improve handling during application [Ackroyd, 1996].
Linseed oil, another commonly employed additive, serves as a plasticizing agent that enhances the working properties of the adhesive medium [Ackroyd, 1996]. Extracted from flax seeds, linseed oil forms a colloidal suspension within the glue-paste, facilitating smoother application and improved wetting properties [Ackroyd, 1996].

Molasses and honey, prized for their humectant properties, feature prominently as plasticizers in glue-paste linings [Ackroyd, 1996]. These natural sugars attract and retain moisture from the atmosphere, effectively reducing the stiffness of the adhesive component [Ackroyd, 1996].

Wetting agents such as ox gall and vinegar play crucial roles in maintaining the stability of the adhesive mixture and improving surface contact between the adhesive and canvases [Ackroyd, 1996]. Ox gall, derived from ox bladder stones, acts not only as a wetting agent but also as a plasticizer, enhancing the adhesive's flexibility [Ackroyd, 1996]. Similarly, vinegar, with its acidic properties, lowers the viscosity of animal glue, facilitating better penetration and enhancing the uniformity of the bond [Ackroyd, 1996].

Preservatives, albeit in small quantities, serve to prevent mould growth and prolong the lifespan of glue-paste linings [Ackroyd, 1996]. Phenol, a commonly used preservative, interferes with mould metabolism and exhibits acidic properties that inhibit mould formation. And Alum – Aluminum sulfate was used in Florentine recipes. [Ackroyd, 1996]. Following this description of ingredients is a table with a selection of commonly found recipes of glue paste.

Table no. 1: Recipes found in the literature

Source	Recipe Description	Ingredients and Proportions	Functions/Notes
De Burtin's Treatise [Percival-Prescott, 2003]	Recipe 1: Glue mixture for general use	- Venice turpentine: 1 lb - White resin: ½ lb - Flour (1 stone) - Thin glue to desired consistency	Provides cohesive adhesive mixture for canvas lining. Venice turpentine is used for its plasticizing effect.
	Recipe 2: Enhanced paste for additional flexibility and smoothness	- Paste: 1 quart - Glue: ¼ pint - Venice turpentine: ¼ pint - Boiled linseed oil: 2 tbsp - Paris White: 1 tbsp	Adds plasticizers and flexibility, enhancing workability and adhesion.
A Method for Lining Canvas Paintings with Glue Composition [Newman, Peter, 2003]	Compo Lining: Rye flour and glue-based composition	- Rye flour: 2 parts - Scotch glue (concentrated): 1 part - Venice turpentine: 1/8 part - Anti-fungal agent (PCMC)	Glue-paste mixture to keep composition pliable and reduce deterioration. Venice turpentine increases flexibility.
	Preparation Method: Preparation of the paste	- Flour slaked in water for 12 hours (creamy consistency) - Cooked for 3 hours with glue added	Creates pliable and stable paste; anti-fungal agent helps prevent microbial growth.
Structural Conservation of Canvases in Russia [Yurovetskaya, Anastasia, 2023]	Recipe 1: Sturgeon glue and honey-based solution for multiple applications	- Sturgeon glue: 1 part (solution 4-8%) - Honey: 1 part - Applied 3 times with varying concentrations	Used for gluing and reinforcing canvas with flexible, strong adhesive properties.

	Recipe 2: Alternative with rabbit skin glue	- Rabbit skin glue: 2 parts - Honey: 1 part	Rabbit skin glue as a substitute for sturgeon glue; used for bonding and flexibility
Linking Past and Future: Forty Years a Liner in Italy [Rossi-Doria, Matteo, 2023]	Traditional Flour & Animal Glue Lining	- Wheat and rye flours - Animal glues (gelatinous) - Additives: honey, molasses, Venetian turpentine, linseed mucilage, vinegar, ox gall, glycerine, oils	Used for canvas facing and lining; enhances adhesion and flexibility; additives improve properties.
Gacha Lining's Treatment Viability [Betancor, Julia; Calvo, Ana; Gil, Rita; Macarrón, Ana, 2023]	Basic Glue-Paste Recipe	- Skin glue (adhesive) - Flour (thickener) - Water (diluent) - Additives: vinegar, honey/molasses/syrup, plants/garlic, salts, gum, ox gall	Provides essential adhesive with plasticizers and surfactants to enhance adhesion and prevent degradation.
Glue-Paste Lining of Paintings: Evaluation of Some Additive Materials [Ackroyd, Paul, 1996]	General Glue-Paste Mix	- Flour (wheat or rye) - Animal glue - Additives: Venice turpentine, linseed oil, ox gall, vinegar, molasses, phenol, hydrogen peroxide	Mixtures vary with different additives for plasticizing, wetting, and preserving; enhance flexibility, adhesion, and longevity.
	Plasticizing Agent	- Venice turpentine - Linseed oil - Molasses	Plasticizers improve flexibility and working properties but may age over time, increasing brittleness.
The Creep Performance of Bio-based and Synthetic Lining Adhesives at different environmental conditions [Poulis, Johannes A.; Seymour, Kate; Mosleh, Yasmine, 2022]	Basic Lining Mix	- Animal skin glue: 2g - Wheat flour: 12g - Water: 72 ml	Simple, early adhesive mix for lining, widely used in France and Italy since the 17th century.

2.1.3 The Lining Process with Glue-paste

Lining paintings with glue-paste is a carefully executed process intended to preserve artworks for the future [Mehra, 1978]. Following historical methods and modern refinements, conservators approach each stage with precision. The painting is first protected with a facing and removed from its stretcher. Once separated, the reverse is cleaned and flattened to prepare for the adhesive application [Hackney, 2020; Percival-Prescott, 2003; Soltan, 2010]. This ensures a smooth, debris-free surface for proper adhesion.

A warm glue-paste adhesive is then brushed evenly onto the original canvas [Hackney, 2020; Percival-Prescott, 2003; Soltan, 2010]. The painting is carefully aligned with a lining canvas to avoid wrinkles or misalignment [Hackney, 2020; Percival-Prescott, 2003]. The canvases are then ironed to activate the adhesive and ensure complete bonding [Hackney, 2020; Percival-Prescott, 2003; Soltan, 2010]. Pressure is applied from the center outward to eliminate air pockets, followed by flattening underweight without manual force [Soltan, 2010]. In some cases, warm sand is spread from the center to the edges, its heat aiding the adhesive's penetration and bonding [Mehra, 1978; Soltan, 2010].

After bonding, the painting is left to dry thoroughly, a process that may take several days depending on environmental conditions. Finally, the facing is gently removed, revealing the stabilized and conserved artwork [Hackney, 2020; Percival-Prescott, 2003].

2.2 Ethical Considerations of Glue-Paste Linings

The use of glue-paste linings in the conservation of canvas paintings has sparked ongoing ethical debates within the conservation community. This chapter explores the ethical considerations surrounding this traditional conservation technique, examining key principles, challenges, and implications for the preservation of cultural heritage.

2.2.1 Lining Concerns in the 20th Century

In conservation history, the 20th century was a pivotal period marked by growing ethical and technical scrutiny of glue-paste linings in canvas painting preservation. Once widely accepted, these practices faced increasing skepticism over their effectiveness and moral implications [Ackroyd, 2002; Ackroyd et al., 2002].

Early literature warned of the risks of moisture, pressure, and heat during lining, noting that excessive ironing or bonding could distort artworks or compress paint layers. Temperatures above the optimal 40–60°C could cause serious structural and visual damage [Stoner, 2012]. Such warnings highlighted the fragility of impastos and challenged the notion of lining as a routine, preventive treatment [Soltan, 2010].

Echoing these concerns, Picault's 1789 critique lamented the loss of originality and vitality caused by linings. Drawing on observations from major collections, he emphasized the harm to authenticity—the need for conservation to respect the artist's creative intent and original execution [Soltan, 2010].

Throughout the 20th century, conservators grappled with the shortcomings of traditional techniques such as hot irons and vacuum hot tables, which often resulted in surface flattening and texture loss [Constantini, 2013; Hackney, 2023; Hagan et al., 2023; Hedley et al., 1984; Mehra, 1972]. These limitations prompted widespread reassessment and the development of gentler, more ethical alternatives.

By century's end, the conservation community increasingly questioned traditional lining practices, drawing on early warnings and critiques to promote more reflective, responsible approaches to preservation [Scharff, 2023].

2.2.2 The Greenwich Conference in 1974

"At first, it was just a shift of emphasis from how a painting should be lined to how a painting should be seen and valued, not only for the image on its face but as an integral object which should be protected and enjoyed in its entirety." – Westby Percival-Prescott April 2003

The 1974 Greenwich Conference represented a pivotal moment in conservation ethics, particularly in relation to glue-paste linings. Bringing together conservation professionals from varied backgrounds, the event provided a forum for critical discussion and collective reflection on the ethical dilemmas posed by traditional lining methods [Stoner, 2023].
Conference participants challenged long-standing assumptions and called for more deliberate, minimally invasive approaches to treatment [Ackroyd, 2002; Andersen, 2013; Constantini, 2013; Fuster-López et al., 2019; Hagan et al., 2023; Hedley et al., 1984; Stoner, 2023], emphasizing the importance of reversibility and risk assessment in guiding conservation decisions.
A central focus was the reassessment of glue-paste linings, long considered standard practice [Ackroyd, 2002; Constantini, 2013]. Concerns were raised about the use of heat and pressure in traditional methods, which risked irreversible alterations or damage to artworks [Andersen, 2023; Coddington et al., 2023; Hackney, 2023; Hedley et al., 1984; Mehra, 1972].
Ultimately, the Greenwich Conference acted as a catalyst for reform, inspiring innovation and a more nuanced understanding of the ethical and technical complexities of lining practices [Ackroyd, 2002; Constantini, 2013; Hagan et al., 2023]. It marked the beginning of a broader process of revision and renewal in conservation [Constantini, 2013].

2.2.3 Evolution since the Greenwich Conference

The Greenwich Conference prompted a series of publications and subsequent studies on conservation [Villers, 2003], with key contributors including Ackroyd, Berger, Hackney, Hedley, Andersen, Lucas, Mehra, Villers, and Young. The latest major contribution is *Conserving Canvas*, published by The Getty Conservation Institute in 2023 [Coddington et al., 2023].
Since the 1974 conference, ethical considerations around glue-paste linings and conservation more broadly have evolved, driven by advances in conservation science, societal attitudes, and interdisciplinary collaboration. Notably, the principle of reversibility has gained prominence, with conservators prioritizing minimally invasive, reversible treatments [Ackroyd et al., 2002; Coddington et al., 2018; Cross et al., 2023; Hagan et al., 2023; Hedley et al., 1984], reflecting awareness of long-term treatment impacts and the importance of preserving artworks' original state [Ackroyd, 2002; Coddington et al., 2018; Constantini, 2013; Hackney, 2004; Hedley et al., 1984].
Interdisciplinary collaboration and scientific research have become central to practice. Developments in materials science, imaging, and analytical techniques have enhanced treatment decisions and understanding of ethical implications [Hackney, 2023; Scharff, 2023; Constantini, 2013; Fuster-López et al., 2019; Hedley et al., 1984].
Shifting attitudes toward cultural heritage emphasize the intrinsic value of artworks and the responsibility to preserve them for future generations, reinforcing conservators' ethical duties [Coddington et al., 2018; Constantini, 2013; Fuster-López et al., 2019; Hedley et al., 1984].
Overall, since the Greenwich Conference, conservation ethics have advanced toward greater professionalism, rigor, and responsibility. Principles of reversibility, interdisciplinary collaboration, and transparency guide conservators in addressing glue-paste linings and other challenges with integrity and respect for cultural heritage.

2.2.4 Ethical Principles and Guidelines

Several key ethical principles emerged from the discourse surrounding glue-paste linings, guiding conservation practices and decision-making:

1. Reversibility and Retreatability: Mehra's report in 1972 emphasized the importance of reversibility in conservation treatments, cautioning against invasive techniques that could irreversibly alter the painting's structure [Andersen, 2023; Constantini, 2013]. This principle highlights the need for treatments that allow for future intervention without compromising the original artwork [Andersen, 2023; Berger, 2003; Constantini, 2013].
2. Preservation of Original State: The shift towards a more minimalist ethic of intervention prioritizes the preservation of the painting's original materials and historical integrity [Coddington et al., 2018; Hedley et al., 1984]. This approach acknowledges the value of retaining evidence of age and acknowledges minor surface irregularities as integral parts of the artwork's history [Hedley et al., 1984].
3. Risk Assessment: Ethical considerations also encompass risk assessment, requiring conservators to carefully evaluate the potential risks and benefits of different treatment options [Andersen, 2023; Constantini, 2013]. This involves weighing the impact of treatments on the structural integrity of the artwork and considering the likelihood of future deterioration [Andersen, 2023; Berger, 2003; Constantini, 2013].
4. Adaptation and Innovation: Conservation ethics encourage adaptation and innovation in response to evolving knowledge and technological advancements [Andersen et al., 2019; Constantini, 2013]. Conservators strive to incorporate new methods and materials that minimize intervention while maximizing the preservation of the artwork's original state [Andersen et al., 2019; Constantini, 2013; Hedley et al., 1984]

2.3 Conservational and Climate-Related Challenges of Glue-Paste Linings

Glue-paste lining, historically carried out by skilled artisans employed by restorers up to the mid-20th century [Hackney, 2004; Spagnol, 2004], involves adhering a secondary canvas to the reverse of the original artwork using an adhesive composed primarily of animal glue and flour [Mosley et al., 2022]. While this technique has been effective in flattening raised cracks and stabilizing deteriorating canvases, it introduces several structural and environmental vulnerabilities [Kadu, 2023]. Over time, both the adhesives and the materials they support undergo significant changes. The "lining cycle" typically spans 100 to 150 years, during which the canvas and adhesive undergo chemical and physical transformations, including continuous dimensional changes that weaken the painting [Hackney, 2020; Mehra, 1972; Villers, 2003]. Adhesion between paint layers can be compromised, leading to delamination and flaking [Göransson et al., 2003; Tassinari, 2003]. An overview table of the different parameters and how they affect the condition of a lined painting can be found at the end of this chapter.

2.3.1 Alteration of the original

One of the primary concerns generally associated with Glue-Paste Lining is the alteration of the painting's artistic integrity. The traditional Glue-Paste Lining is applied with an excessive use of heat, moisture, and pressure in order to melt the adhesive, to attach the two canvases onto each other, to plasticize the paint, and flatten any deformation of the original painting. For this process, hot irons were often used to heat and flatten distortions [Ackroyd, 2002]. Disastrous, but common results of this procedure were the reinforcement of the canvas texture into the paint layer, the frequent flattening of impasto leading to artist's precise brushstrokes being lost forever [Ackroyd, 2002; Ackroyd et al., 2002; Constantini, 2013; Cummings et al., 2003; Cummings et al., 2003; Dwivedi et al., 2023; Fieux, 1974; Hackney, 2004; Hackney, 2020].

2.3.2 Properties of Glue-Paste Lining

The properties and deterioration of glue-paste linings are influenced by both the lining materials and adhesives used. The mechanical behavior of lined canvases is strongly affected by fabric characteristics, including type, weave structure, and fibre composition, which determine flexibility, texture, and absorbency [Jardine et al., 2012; Young, 2023]. Natural fibers such as silk, cotton, and linen are commonly used for their favorable mechanical properties [Young, 2023], while weaving factors—yarn type, diameter, and density—further influence stiffness, permeability, and flexibility [Young, 2023].

Linen canvases show significant loss of flexibility and tensile strength over time due to cellulose chain breakdown, causing embrittlement [Bräunig et al., 2023; Cruickshank et al., 2007; Hackney et al., 1981]. Chemical degradation occurs via hydrolysis and oxidation, reducing elasticity and increasing susceptibility to tears, distortions, and structural instability [Hackney, 2020; Cruickshank et al., 2007]. Aging also affects peel force: close-weave fabrics tend to show higher peel force, while open-weave fabrics decrease. The type of flour, milling degree, and fabric density influence mechanical and dimensional stability as well as paint layer failure risk [Andersen et al., 2023].

Animal glues, particularly hide glues, are highly sensitive to relative humidity, developing internal stresses when restrained and losing strength or undergoing biodeterioration above 70% RH [Andersen et al., 2023]. Glue-paste flours contain starch, proteins, and lipids, with starch properties—solubility, water retention, swelling, viscosity—depending on amylose-amylopectin ratio, granule size, and botanical origin. Protein content also affects adhesive rheology [Andersen et al., 2023].

2.3.3 Environmental Impact on Glue-paste Linings

Environmental conditions—especially relative humidity (RH) and temperature—strongly affect the performance and longevity of glue-paste linings, causing delamination, distortion, and biodeterioration [Constantini, 2013; Kadu, 2023]. Temperature fluctuations alter the mechanical properties of linings: heating increases flexibility and expansion, while cooling causes contraction and rigidity. Below the glass transition temperature (Tg), materials are dense and brittle; above Tg, they become rubbery, allowing deformation under stress. Such thermal shifts influence shrinkage and elastic modulus (E), affecting stress and strain within the canvas and adhesive layers [Hackney, 2020].

Glue-paste linings, though structurally stable under controlled conditions (50% RH) [Mosley et al., 2020], are highly sensitive to RH changes [Andersen, 2013; Andersen et al., 2022; Cruickshank et al., 2007; Hedley, 1981]. Moisture variations alter stiffness and strength [Cruickshank et al., 2007], though aging reduces responsiveness [Cruickshank et al., 2007]. Being hygroscopic, glue-paste undergoes dimensional changes at both low and high RH [Andersen, 2013; Hough et al., 2023]. Elevated RH promotes swelling, fungal growth, and structural decay [Constantini, 2013; Kadu, 2023], while temperature fluctuations worsen stress-induced damage [Kadu, 2023]. Moisture ingress plasticizes adhesives, lowering strength and stiffness and leading to premature failure [Mosley et al., 2022]. Even minor RH shifts can cause tension changes [Ackroyd et al., 2001]. At higher RH (above 70%), adhesives expand and may transition from a glassy to rubbery state, reducing mechanical performance [Coddington, 2023; Mosley et al., 2022]. Prolonged RH above 75–80% fosters fungal growth [Garofalo et al., 2019].

Conversely, low RH makes adhesives brittle. Glue-paste retains flexibility through absorbed moisture, but prolonged dryness causes crystallization of humectant sugars and contraction of animal glues, inducing tensile stress and cracking [Andersen, 2013; Andersen et al., 2017; Coddington, 2023]. Cyclic RH changes lead to shrinkage, cracking, and eventual paint loss [Andersen, 2013; Andersen et al., 2017; Hackney, 2020; Coddington, 2023].

Biological deterioration results from fungi, bacteria, and insects [Kadu, 2023; Oberthaler, 2023]. Fungi thrive in moist environments, digesting organic materials in canvases and adhesives [Kadu, 2023]. High RH accelerates mould growth, which releases enzymes that degrade adhesives and supports, often following water incidents such as leaks or floods [Hackney, 2020]. Common effects include staining, structural damage, and material loss [Kadu, 2023; Oberthaler, 2023]. The organic composition of glue-paste makes it highly vulnerable, with semi-whole flour recipes being most susceptible [Andersen et al., 2017].

Insect infestations, notably by the Biscuit beetle (*Stegobium paniceum*), pose serious risks to glue-paste linings, particularly in Malta and regions using starch-based adhesives [Lentini, 2012]. Female beetles lay eggs in glue layers, and larvae tunnel through the adhesive, leaving flight holes and frass that weaken the bond between canvases. This tunneling can cause paint flaking, tears, and loss of structural integrity, typically progressing from the painting's edges inward through successive generations [Lentini, 2012].

Table no.2: Parameters in the conservation of paintings lined with glue-paste

Parameter	Influence on Conservation & Optical Results
Fabric Type (Linen, Cotton, Silk)	Determines strength, flexibility, and longevity. Linen strong but becomes brittle; cotton flexible but weaker; silk smooth but prone to tearing. Influences absorbency and tension behaviour [Hackney & Hedley, 1981; Jardine & Young, 2012; Ackroyd, 2002].
Weaving Structure (Close/Open weave)	Close weave = higher structural support but less flexible, higher peel forces; open weave = more flexible, breathable, less stable [Hedley, 1981; Andersen, 2013; Ackroyd et al., 2002].
Stitching of Multiple Pieces	Poor stitching creates weak points, visible seams, stress concentrations, risk of delamination and biological attack [Andersen et al., 2017; Hackney, 2020; Percival-Prescott, 2003].
Glue Components (Animal glue, starch, flour)	Adhesives sensitive to RH and temperature; starch/glue become brittle or soften; ageing weakens bond, risking paint loss [Ackroyd, 1996; Andersen et al., 2023; Keck, 1977].
Fabric Stretching (Pre/Post)	Uneven tension causes deformations/wrinkles; over-tightening leads to cracking; dimensional change with RH fluctuations [Andersen & Fuster-López, 2019; Chittenden et al., 2003; Hackney, 2020].
Warp & Weft Orientation	Warp = stronger, less stretch; weft = more flexible; misalignment causes uneven stress and distortions [Hedley, 1981; Jardine & Young, 2012; Andersen et al., 2022].
Stretcher Type	Rigid stretchers can over-stress canvas; flexible designs help in fluctuating RH; incorrect sizing risks warping [Hackney, 2020; Hagan, 2023; Andersen, 2013].
Climate (T & RH)	Fluctuations cause expansion/contraction, stress, and adhesive failure; stable 18–22 °C and 45–55 % RH ideal [Michalski, 1993; Ashley-Smith, 1999; Thomson, 1986]
Airborne Pollutants	SO_2, NO_x, O_3, particulates degrade fibers and adhesives; long-term exposure causes yellowing, weakening [Tétreault, 2003; Grzywacz, 2006; Hackney, 2020].
Biological Agents (Fungi, bacteria, insects)	Fungi digest organic adhesives; insects (e.g. biscuit beetle) tunnel through glue, causing structural loss [Lentini, 2012; Andersen et al., 2017; Göransson & Hallström, 2003].
Fungal Growth (High RH)	Enzymatic breakdown of canvas and glue leads to stains, discoloration, paint loss [Göransson & Hallström, 2003; Kadu, 2023; Andersen et al., 2023].
Insect Infestation	Larvae create holes and frass, starting at glue-rich edges; can cause irreversible damage [Lentini, 2012; Andersen et al., 2017; Göransson & Hallström, 2003].

2.4 Post-Lining Options and Alternatives to Lining

Due to all these conservational challenges posed by Glue-Paste lined paintings, post-lining options and alternatives to linings became more and more relevant over the last decades. Some of the options and alternatives will be discussed in the following chapter.

2.4.1 Delining

Delining, the process of removing a secondary canvas adhered to an original painting, is a significant intervention often reserved for cases where the lining has failed [Hackney, 2020]. The decision to delining typically stems from an assessment of the adhesion between the lining canvas and the original canvas, alongside the reappearance of cupping or other distortions in the paint layer, and considering the conditions under which the painting is stored or exhibited [Andersen, 2013].

Traditionally, delining is performed mechanically, involving the removal of lining in strips and scraping with a scalpel. However, this method carries a significant risk of cutting or damaging the original canvas [Essex, 2003; Hackney, 2004]. Such mechanical processes are often crude and laborious, potentially weakening the original painting further [Ackroyd, 2002].

In recent years, there have been proposals to use enzymes to remove degraded glue-paste adhesive. Enzymatic removal presents its own challenges, primarily in controlling the specific conditions needed for effective action and in preventing enzymes from attacking the original proteinaceous materials, such as the glue size layer. Enzymes are typically carried in aqueous suspensions, which can exacerbate these issues [Ackroyd, 2002]. Another modern technique under study involves using Femtosecond lasers to remove or denature old lining glue, increasing its friability. Nevertheless, this approach also faces difficulties in differentiating between the organic layers of the lining and the original painting [Ackroyd, 2002].

The complete extraction of impregnating adhesives like glue-paste from the original canvas is practically impossible [Ackroyd, 2002].

2.4.2 Relining

In most cases, a painting that has been lined with Glue-Paste in the past will not remain in that state of condition for an unlimited amount of time. After around one century, the canvas and the glue used for lining will be weakened due to microbiological attack and the consumption of organic material or mechanical weakening by climate change [Hackney, 2004]. This leads to the “Lining Cycle”, as Westby Percival-Prescott concluded in the 1970s, in which a lined painting will always need to be relined due to the limited lifespan of materials [Percival-Prescott, 2003]. The primary objectives of relining are manifold: to reinforce the original support, enhance density and integrity, rectify deformities, and arrest the decay process [Yashkina, 2003]. Paintings exhibiting signs of wear and tear, including hard deformities and crumpled canvases, are prime candidates for relining, as the procedure not only addresses existing issues but also prevents further deterioration [Yashkina, 2003]. There is a large variety of different adhesives, fabrics, and techniques to perform a relining that need to pass a selection based on multifaceted requirements [Andersen, 2023; Mosley et al., 2022]:

2.4.3 Requirements for a Relining

Central to the ethos of relining is the principle of reversibility [Andersen, 2023; Mehra, 1972]. This foundational tenet emphasizes the preservation of artistic integrity by ensuring that interventions remain inherently reversable, allowing for future treatments with minimal impact on the artwork. However, the practicality of full reversibility is often challenged, leading to a nuanced approach that prioritizes removability and retreatability as viable alternatives [Andersen, 2023].

Reversibility refers to the principle that any conservation or restoration treatment applied to an artwork should be capable of being undone in the future, without causing damage to the original material or altering the artwork's integrity [Stoner, 2012]. This means removability, which is the desired principle. However, full removability is basically impossible, and therefore reversibility is often used in terms of retreatability. Retreatability refers to the capacity to re-treat or re-address a conservation intervention or process in the future, without causing damage to the artwork or altering its original state. It emphasizes the ability to build upon or revisit previous treatments in a controlled and predictable manner [Muñoz Viñas, 2005].

Equally paramount is the preservation of the painting's structural character [Andersen, 2023; Mehra, 1972; Scharff, 2023]. The relining process should not impose alterations that compromise the original composition or material integrity. This necessitates a delicate balance between preservation and intervention, with a keen awareness of the painting's inherent vulnerabilities.

Flexibility has been seen as a requirement, envisioned as an enduring attribute that withstands the test of time [Andersen, 2023; Cruickshank et al., 2007; Mehra, 1972; Scharff, 2023]. While historically debated—Mehra advocating for both flexibility and stiffness [Andersen, 2023; Cruickshank et al., 2007; Scharff, 2023; Young, 1999]—contemporary research underscores the importance of maintaining a degree of suppleness to mitigate the risk of further damage. Young states, the lining should move sympathetically with the painting in order to avoid additional stress between the layers [Cruickshank et al., 2007]. Yet, the quest for flexibility must navigate the complexities of material selection and adhesive

properties, acknowledging the multifaceted nature of compatibility [Andersen, 2023; Ravnikar, 2014; Young, 1999].

Material Compatibility in the context of the conservation of easel paintings refers to the degree to which a conservation material or treatment aligns with the physical, chemical, and aesthetic properties of the original artwork's materials. It ensures that any intervention supports the long-term stability and integrity of the artwork without causing adverse effects.

The avoidance of invasive techniques, such as heat application, resonates throughout the discourse on relining [Andersen, 2023; Scharff, 2023]. Heat, alongside other degradation agents like moisture and pressure, poses significant risks to the artwork, potentially altering its chemical composition and structural integrity. Compatibility, both in terms of material interactions and adherence to the original aesthetic and handling properties, assumes paramount importance [Cruickshank et al., 2007]. A relining fabric must possess isotropic behavior, excellent durability, negligible hygroscopicity, and resistance to creep, acidic pollutants, and light, aligning seamlessly with the painting's intrinsic characteristics [Cruickshank et al., 2007; Young, 1999].

Ultimately, the requirements for a relining are not cast in stone but rather guiding principles informed by empirical knowledge and practical experience [Andersen, 2023; Scharff, 2023]. Many authors have written down and published their knowledge about this topic over the last decades. *Conserving Canvas* by The Getty Conservation Institute is the latest addition to that knowledge and presents important information about the current state of conservational considerations. Each treatment must be tailored to the unique challenges presented by the artwork, honoring its cultural history while ensuring its preservation for generations to come.

2.4.4 Alternatives to Lining

A range of alternative methods have emerged, offering innovative solutions to address the unique challenges posed by each artwork and gradually replaced the traditional method of Glue-Paste Lining.

2.4.4.1 Preventive Conservation

Preventive conservation focuses on creating and maintaining an environment that minimizes the risk of damaging artifacts, including canvas paintings. It refers to measures and strategies designed to avoid or reduce the risk of deterioration and damage to cultural heritage objects. This approach includes controlling environmental conditions, enhancing handling procedures, and utilizing protective measures during transport and display [Hagan et al., 2023; Hackney et al., 1993; Hackney et al., 1981; Hackney, 2023]. Due to these measures, conservators can extend the lifespan of these artworks while maintaining their original character as much as possible and hence reducing the need for procedures like lining [Andersen, 2013; Coddington, 2023; Hackney, 2004; Oberthaler, 2023; Stoner, 2012].

A stable environment typically maintains temperature between 18 and 22°C and relative humidity around 45–55%, minimizing fluctuations that can cause canvas and paint layers to expand or contract, leading to structural damage [Ashley-Smith, 1999; Michalski, 1993]. Lighting must be carefully

controlled, with sensitive pigments exposed to no more than 50–200 lux and UV radiation filtered out [CIE, 2004; Thomson, 1986]. Air quality is equally crucial, requiring the reduction of dust, gaseous pollutants, and volatile organic compounds through appropriate filtration and material choices [Tétreault, 2003; Grzywacz, 2006]. Moreover, preventive strategies include monitoring for pests and mold, minimizing physical handling, using archival-quality storage supports, and preparing emergency plans to address risks such as water leaks, fire, or earthquakes [Staniforth, 2000; Caple, 2011; CCI, 2014].

2.4.4.2 Preliminary Treatments

While lining was traditionally seen as a preventive measure to stabilize a painting and not customized to the specific needs of each artwork, the paradigm shift that occurred in the structural treatment of canvas paintings led to a more specific approach. Preliminary treatments involve minimally invasive procedures designed to stabilize and repair specific areas of damage. These treatments are often employed to manage minor tears, holes, and delaminations, reducing the necessity for more extensive procedures like lining [Keck, 1977; Books et al., 2023; Chittenden et al., 2003; Demuth et al., 2023; Garofalo et al., 2019; Hackney, 2004; Hackney, 2020; Oberthaler, 2023; Soltan, 2010].

2.4.4.3 Loose Lining

Loose linings have become a preferred alternative to traditional glue-paste linings for conserving canvas paintings. This non-adhesive method offers a less invasive backing that protects against dirt and pollution while maintaining structural integrity [Andersen, 2013; Hackney, 2020]. Using materials like polyester sailcloth significantly reduces air transport through the reverse of the painting, preventing particulate and gaseous pollution and limiting biological deterioration [Hackney, 2004].

Polyester also provides stability, as it does not relax or creep like traditional canvas, allowing paintings to be stretched less tightly and reducing long-term tension loss [Hackney, 2004]. The main drawback is that it covers the reverse of the original canvas, restricting access for future treatments, though the process remains fully reversible [Hackney, 2004; Hackney, 2020].

2.4.4.4 Stretcher-bar Lining

Stretcher-bar linings—a form of loose lining where a fabric such as polyester sailcloth is attached to the stretcher from the back—provide added support by creating a tensioned structure that prevents the canvas from flapping against the stretcher [Hackney, 2020]. This is crucial, as many old paintings show cracks along stretcher edges and crossbars caused by such movement [Hackney, 2004]. During transport, paintings are exposed to vibrations that can cause damage; stretcher-bar linings help by raising the vibration frequency to about four times the canvas's natural frequency, reducing resonance. The air pocket between the lining and canvas also acts as a cushion, absorbing vibrational energy and protecting the artwork. These features make stretcher-bar linings vital for preserving paintings during transport and loans [Hackney, 2004; Hackney, 2020].

2.4.4.5 Strip-Lining

The tacking edges of canvas paintings are often more damaged than the rest due to rusted tacks, contact with resinous wood, handling, and higher stresses at tensioned edges, which can lead to tearing [Hackney, 2020]. Strip-lining, which reinforces these edges with fabric strips, provides structural support to the painting.
BEVA 371, a synthetic ethylene-vinyl acetate copolymer adhesive, is now the most common choice for strip-lining because of its flexibility, strong adhesion, and compatibility with various materials [Ackroyd, 2002; Berger, 2003; Garofalo et al., 2019; Hackney, 2020; Oberthaler, 2023]. It replaced wax-resin adhesives and is typically heat-sealed around 65°C, forming a stable bond resistant to RH fluctuations [Ackroyd et al., 2001; Hackney, 2004; Hackney, 2020; Mosley et al., 2022].
Polyester sailcloth is preferred as the strip-lining fabric for its thinness, stability, and resistance to environmental change [Ackroyd et al., 2001; Hackney, 2004]. Its minimal thickness also reduces edge deformation and surface distortions [Hackney, 2004; Hackney, 2020; Michalski, 1996].
Preparation involves chamfering or feathering the fabric edges to blend with the original canvas, or cutting them in a zigzag pattern to reduce visible transitions [Hackney, 2020; Cruickshank et al., 2007].
The main advantage of strip-lining is its local, minimally invasive nature, which preserves the artwork's integrity and historical value [Hackney, 2020; Lucas, 2003]. It is most effective when the canvas can still withstand restretching without full lining [Cruickshank et al., 2007; Hackney, 2020]. However, severely weakened canvases may require more extensive treatments [Hackney, 2020].
Care must be taken to avoid new stresses: high activation temperatures or deep penetration of BEVA 371 can increase rigidity and transfer tensile stress to the original canvas, causing fractures [Andersen, 2019].

2.4.4.6 Mist-Lining

The Mist-Lining Technique emerged as a response to the limitations and challenges posed by traditional methods such as Glue-Paste Lining. The latter involved the application of adhesive pastes, often altering the original texture and appearance of the artwork if excessive heat and pressure are applied. Mist-Lining, originating in the studies by Jos Van Och at the Stichting Restauratie Atelier Limburg (SRAL) in Maastricht during the 1990s, this technique reaches a delicate balance in offering a suitable support for the painting while minimizing adverse effects.

Central to Mist-Lining is its commitment to non-invasiveness and reversibility, guided by principles deeply rooted in the ethical considerations of art restoration. Unlike the traditional lining methods, Mist-Lining builds upon the foundational principles of Mehra's technique of Cold Lining [Books, Long, Pocobene, 2023, Ravnikar, 2014], sidesteps the use of excessive heat, moisture, or high pressure, preserving the integrity of the original structure and texture of the artwork [Cummings et al., 1975; Keyser, 1984].

Cold lining, pioneered by Vishwa Raj Mehra in the early 1970s [Mehra, 2003; Mosley et al., 2022], marked a significant shift in painting conservation methods [Arkaduisz et al., 2022; Books et al., 2023; Mosley et al., 2022]. Departing from traditional techniques involving excessive use of heat, pressure, and moisture, cold lining aimed at minimizing the impact on artworks during treatment while ensuring reversibility [Books et al., 2023; Mosley et al., 2022]. Mehra's approach prioritized containment and control of adhesive, reducing weight and stress on paintings [Books et al., 2023; Mosley et al., 2022]. The introduction of suction tables by Mehra, Hacke, and Willard in the 1970s/1980s further refined cold

lining [Essex, 2003]. Mehra's method utilized a nap-bond system and low-pressure suction tables, ensuring controlled conditions for adhesive application and drying [Books et al., 2023; Essex, 2003].

The adhesive of choice, often Plextol B500, is applied in minimal quantities using a low-pressure spray gun, ensuring a delicate balance between adhesion and reversibility [Andersen et al., 2022; Books et al., 2023].

Plextol B500 is a versatile acrylic dispersion favored in art conservation for its adhesive qualities and stability. It features a glass transition temperature of 9°C and reactivation temperature around 80°C, with 600% elongation at break, making it ideal for flexible yet strong bonding [Arkadiusz et al., 2022; Mosley et al., 2022]. Compared to other adhesives in tests, Plextol B500 was the most resistant to peel strength changes over time [Arkadiusz et al., 2022; Duffy, 1989; Fuster-López et al., 2012] and presents a good resistance towards fluctuations in climatic conditions [Andersen, 2013; Mehra, 1972; Mosley et al., 2022]. This adhesive is a low-cost, easily accessible, and reversible adhesive due to its water solubility [Rossio-Doria, 2023]. It is applied cold in very low concentrations, with little weight, and can be thickened to limit the penetration even further [Fuster-López et al., 2012; Mehra, 1972]. The use of moisture in the treatment is eliminated by solvent activation [Ackroyd, 2002]. One drawback of Plextol B500 is its tendency to yellow over time [Ackroyd, 2002; Andersen et al., 2022; Duffy, 1989; Fuster-López et al., 2012], which, however, does not compromise its advantages as a lining adhesive. In general, acrylic dispersions are rather short-lasting in the market; manufacturers frequently change their compositions or may discontinue their production [Hackney et al., 1993; Haller et al., 2023; Mosley et al., 2022].

Unlike traditional lining methods, Mist-Lining involves the strategic spraying of acrylic dispersion resin onto an auxiliary canvas, creating a nap-bond between the original and lining canvases. This adhesive mist, deposited around raised fibers, forms a thread-like structure, allowing for gentle support without impregnation or alteration of the painting's appearance [Books et al., 2023; Ravnikar, 2014]. The technique's flexibility allows for tailored solutions, ensuring optimal support while preserving the unique characteristics of each artwork [Andersen et al., 2022; Books et al., 2023].

2.5 Conclusion on Glue-Paste Lining

By understanding the historical context of Glue-Paste Linings, highlighting its widespread usage and the associated conservational and climate-related challenges, conservators evolved their ethical considerations, driven by a desire to preserve cultural heritage while minimizing intervention.

Particularly, the alteration of the original artwork, influenced by the excessive use of heat, moisture, and pressure during the lining process, raises concerns regarding the preservation of artistic integrity. The mechanical and chemical behavior of lined canvases, influenced by the properties of the lining materials and adhesives, further complicates conservation efforts. Especially, temperature and relative humidity fluctuations pose significant challenges to the longevity and performance of glue-paste linings, leading to delamination, distortion, and biodeterioration.

The examination of glue-paste lining in canvas painting conservation underscores the intricate balance between preserving artistic integrity and addressing the challenges posed by time and environment.

These challenges laid the groundwork for innovative solutions and alternatives to address the unique condition of each artwork, emphasizing reversibility, structural integrity, and non-invasiveness. By considering these options, conservators can tailor conservation treatments to the specific needs of each artwork, promoting its preservation while respecting its cultural and artistic value.

3
CONSERVATION AND RESTORATION TREATMENTS ON BAROQUE PAINTINGS IN MALTA

This dissertation is not only a theoretical piece of work, but also includes a practical point of view in the form of two different case studies that were analyzed and treated as part of an internship at the governmental institution Heritage Malta[1].

These case studies were both created in the Maltese Baroque period and have been lined during the 20th century.

3.1 Baroque Art in Malta and Conservation and Restoration Practice of the 20th-Century Malta

The period of cohabitation with the Order of St John (1530-1798) profoundly influenced Maltese identity, with art and architecture playing a crucial role. This era inspired the Maltese elite to adopt the Baroque style, which became a core component of their cultural identity. Valletta's Baroque architecture and the ornate interior of St John's, featuring works by Caravaggio and Mattia Preti, marked the zenith of Baroque in Malta [Xuereb, 2019].

Many of these artworks created in the Baroque era have been restored and conserved over time. The conservation and restoration practice of 20th-century Malta was highly affected by the events and the aftermath of World War II. With the great level of destruction and chaos it brought, many artworks had to suffer a lot and needed intensive treatments. Due to a shortage of materials, limited human resources, lack of storage facilities, and financial resources, the treatments were performed under difficult conditions, often carried out by artists instead of trained conservators [Spagnol, 2004].

The lining of a painting was a commonly practiced treatment in that period of time and was carried out on numerous artworks. Due to the already mentioned shortcomings after the war, materials and especially large-sized, high-quality canvases were hard to find, and often multiple pieces of canvas, made from cloth sacks, were stitched together [Spagnol, 2004]. The adhesive used for the lining process was the traditional *colla paste*, glue-paste consisting mainly of flour and *colla forte* or rabbit-skin glue and some additives like plasticizers and biocides [Spagnol, 2004].

[1] Heritage Malta is the Maltese national agency for museums, conservation practice and cultural heritage created in 2002. More information: https://heritagemalta.mt/about/

3.3 Case Studies in the Paintings Conservation Department of Heritage Malta

The two case studies belong to a set of paintings by the same artist, the Maltese baroque painter Stefano Erardi.
Stefano Erardi, 1630-1716, was the most significant Maltese painter of the late seventeenth century. Erardi was the closest to come to Classicizing Baroque in Malta, clearly inspired by Annibale Carracci, Guido Reni, and Guercino [Xuereb, 2019; Xuereb, 2021].
Although all aspects of these case studies were analyzed and extensive treatments have been carried out, in this dissertation, only the analyses, decision-making, and intervention regarding the lining will be discussed thoroughly.

3.3.1 Case Study no. 1: Saint Thomas by Stefano Erardi

Figure no. 1: Saint Thomas by Stefano Erardi, Front side before Treatment

Figure no. 2: Saint Thomas by Stefano Erardi, Backside with Raking Light before Treatment

The 17th-century painting of St. Thomas by Stefano Erardi, part of Malta's national collection, holds cultural, historical, and religious significance, having moved from the Grand Master's Palace to various government offices over time. Originally created for devotional purposes, its dramatic chiaroscuro and iconic depiction of the Apostle—patron of builders and carpenters—were intended to inspire reflection and faith, though repeated relocations and conservation interventions have somewhat diminished its original liturgical role. As public property, the work is managed under national heritage policies, which shape decisions on its preservation, display,

and accessibility, while also reflecting the challenges inherent in caring for a large state-owned collection. Its conservation history includes a 20th-century lining that obscured the original canvas, as well as past cleanings, retouchings, and damage from dirt, water, and corroded tacks, all of which have impacted the paint layers and structural integrity. These conditions underscore the delicate balance between safeguarding artistic and historical value and addressing the practical realities of long-term preservation within public stewardship.

3.3.1.1 Object Identification

The painting features a dark background with an aged man, identified as St. Thomas the Apostle, at the center. He has gray hair and a beard, looks to the right, and wears a half-yellow, half-green robe. He holds a paper with a geometrical drawing in one hand and dividers in the other, symbolizing his patronage of builders and carpenters. The composition displays strong light-dark contrast, with chiaroscuro typical of the 17th century. The work is attributed to Maltese artist Stefano Erardi (1630–1716) and is part of a series depicting the Apostles.

The auxiliary frame is a wooden strainer with simple mortise joints, unbeveled edges, and two metal nails per joint, suggesting a later addition. The canvas has a dark red ground layer, likely part of Erardi's double-ground system with ochre underneath and a dark red oil-bound imprimatura. The paint layer was applied meticulously, covering most of the ground, unlike other 17th-century artists who left the dark ground as a middle tone. Oil paint was applied thinly in layers: the dark greenish-black background, then St. Thomas, with contrast modeled via fine glazes. Highlights were added with opaque white and visible, spontaneous brushwork, particularly in hair, yellow robe areas, and skin. The palette includes dark background tones, yellow and green of the robe, skin tones, and brown, black, and white.

Under UV light, the varnish appears evenly applied with greenish fluorescence, suggesting a natural resin composition.

3.3.1.2 Previous Interventions and Condition Assessment

The original support of the painting was covered by a 20th-century lining made of jute, and the original canvas margins had been cut around the painted area. The lining consisted of three pieces of plain-woven canvas sewn together, with a vertical seam on the left side and a shorter horizontal seam connecting the upper third to the lower part. The threads were irregular in shape and thickness, suggesting a handmade origin. The Baxter Thread Counting Method showed 8 threads/cm horizontally and 9 threads/cm vertically. The margins were fixed with highly corroded tacks, some with additional holes, and the strainer frame adhered to the lining, causing deformations. The lining adhesive was a brown, flexible material, likely a glue-paste mixture of flour and animal glue.

The lining presented surface dirt, especially in the corners and lower half, consisting mainly of dust and spider webs, as well as a large vertical water stain, darker discolorations, and three spots covered with white filling. Imprints from the lining seams were visible on the front of the painting, contributing to abrasions during past cleaning campaigns. The paint layer displayed extensive overpaints and reintegrations, particularly in the Apostle's face, hands, and dark background, covering larger areas than original losses. The canvas texture was clearly visible in some areas, likely due to high pressure and heat during past lining interventions.

The painting exhibited a stable pattern of craquelure, small holes, surface dirt, and signs of chemical damage. Thinning of the paint layer revealed the ground color beneath. Under UV light, the varnish showed greenish fluorescence, suggesting a natural resin, with evidence of retouches above and below the layer, yellowing due to aging, and residues of an older varnish in between brushstrokes.

The lining's seams have created deformations and aesthetic concerns, posing a potential risk of paint cracking. However, delining carries high mechanical risk. Currently, the painting is stable, under good tension, and the lining shows no signs of biodegradation, loss of tension, or failure.

3.3.1.3 Treatment Proposal

In order to determine the most appropriate treatment for this case study, three different treatment proposals were prepared: minimum, intermediate, and full. The minimum treatment focuses on assessing the urgent conservation challenges and implementing necessary aesthetic improvements. The intermediate treatment goes further by addressing the urgent conservation needs to ensure the current stability of the artwork while also considering its aesthetic state. This approach aims to restore the artist's presumably intended appearance and to enhance the painting's aesthetic and artistic value. In practice, this involves the careful removal and improvement of visible old interventions and altered materials, such as overpaints, retouches, and yellowed varnish. The full treatment, on the other hand, addresses both current and potential future conservation challenges. It encompasses all aspects of the painting and its framing, including structural stability, aesthetic considerations, and measures to prolong the artwork's lifespan while preventing further damage.

For the purpose of this dissertation, the most relevant observations are derived from the painting's verso. The original canvas is covered with a lining, which has implications for the treatment strategy. Considering the general good condition of the painting, an intermediate treatment was selected as the most appropriate approach for this case study. The only concern regarding the lining is aesthetic

rather than structural. The potential risks associated with removing the lining are therefore considered to be greater than any concerns regarding its current condition. As a result, it was decided not to intervene with the lining and not to remove the lining materials from the painting. Provided that the existing lining continues to offer adequate support, is not significantly degraded, and does not pose substantial risks to the original material, it will be preserved in its current state.

Figure no. 3: Saint Thomas by Stefano Erardi, Front side before Treatment, Raking Light

3.3.2 Case Study no. 2: Saint Andrew by Stefano Erardi

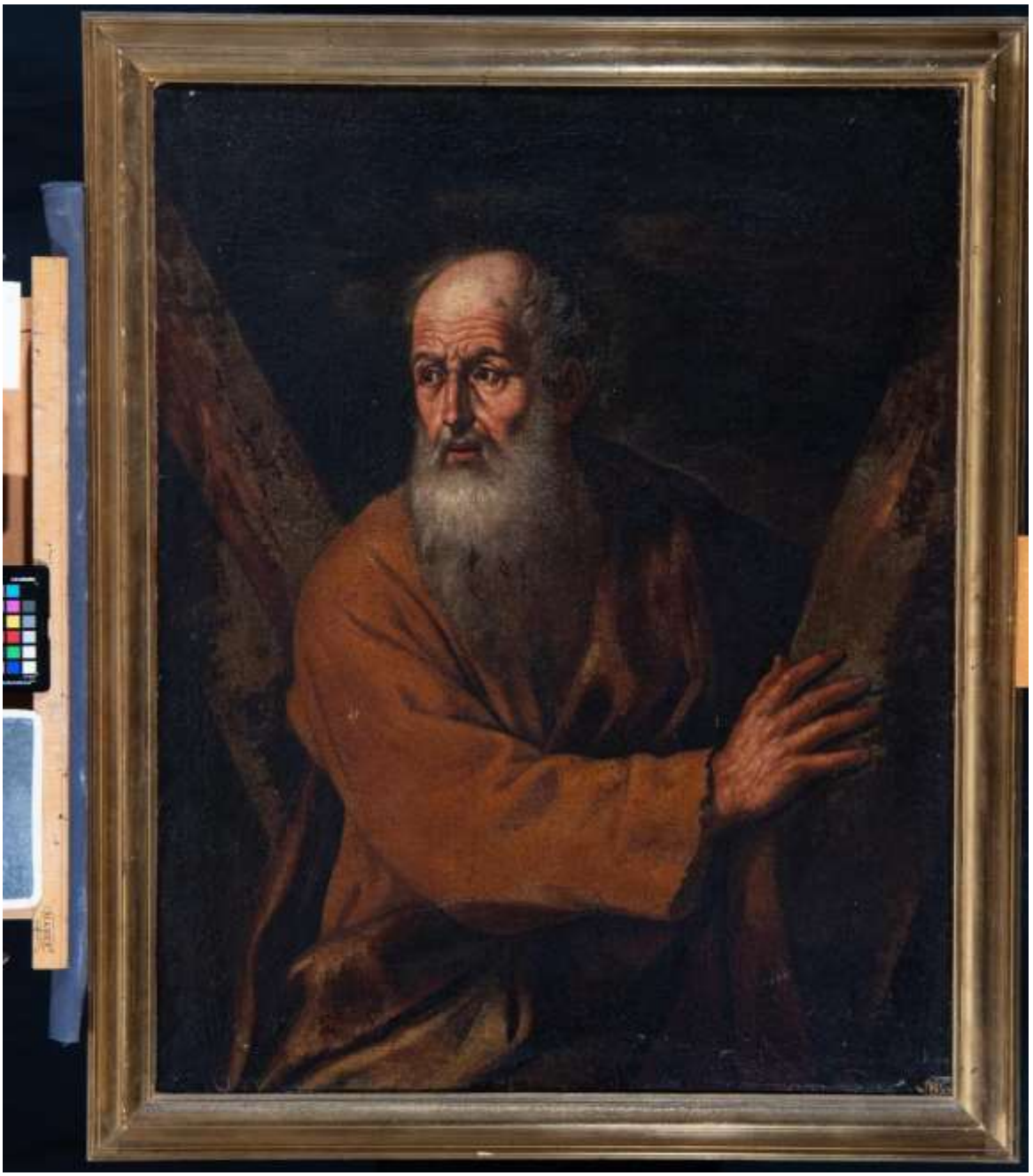

Figure no. 4: Saint Andrew by Stefano Erardi, Front side before Treatment

Figure no. 5: Saint Andrew by Stefani Erardi, Backside before Treatment

This painting of St. Andrew, like the "Saint Thomas" artwork, forms part of Malta's national collection and bears labels linking it to governmental institutions such as the Ministry of Foreign Affairs and the Museum Department. Its status as public property underscores its significance within the nation's cultural heritage, shaping both its accessibility and the state's responsibility for its preservation. Originally intended as a devotional object, depicting the Apostle and patron saint of Scotland, the painting has transitioned from an active role in religious practice to serving primarily as a cultural artifact with enduring spiritual symbolism. Its state ownership means that decisions regarding display, interpretation, and conservation fall under public institutions, guided by policies that prioritize long-term preservation and public engagement. However, the work's condition poses pressing challenges: lined with a mechanical canvas, it shows insect damage, accumulated dirt, degradation of the original

support, and overzealous past retouching that has caused discoloration and diminished authenticity. These factors highlight the need for carefully planned conservation measures to stabilize the structure and safeguard its historical and artistic integrity for future generations.

3.3.2.1 Object Identification

The second case study is a painting of the Apostle St. Andrew by Maltese artist Stefano Erardi, part of a series depicting the Apostles. St. Andrew is shown as an aged man with a long grey beard, wearing an orange-brown garment and carrying a large cross, facing left. He is identifiable by his typical attributes: the beard and the cross he was hanged on. The figure is painted in earthy tones, while the brighter face and beard contrast dramatically with the dark background. The use of chiaroscuro is typical of the 17th century.

The painting is supported by a wooden stretcher frame with simple mortise corners, beveled edges, and two stretching bars per corner. A mechanically manufactured auxiliary frame suggests a later addition. The original canvas is covered by a lining canvas. Ground layers resemble those in the other case study, with oil-based paint applied in layers: a brown medium-dark underlayer, followed by browns, oranges, and reds for St. Andrew, then brighter colors and fine highlights with light impasto to enhance contrast and three-dimensionality. The dark background was added last to frame the figure and create depth. Main colors include dark background, earth tones for clothing and cross, and grey and white for the beard.

Under raking light, the varnish appeared blotchy, and UV examination revealed greenish fluorescence in some areas, suggesting a natural resin varnish, though scientific analysis is needed to confirm the materials.

3.3.2.2 Previous Interventions and Condition Assessment

The original canvas was mostly covered by a lining canvas, visible only in small areas, showing a coarse, plain-woven canvas with a loose pattern. The painting's edges were framed with wood fixed by metal nails.

The painting has been lined to a thin, beige, plain-woven canvas, possibly cotton (scientific analysis required). The lining threads were regular and tightly woven, suggesting mechanical manufacture. Based on common practices, the adhesive was likely protein-based, a glue-paste mixture of flour and animal glue. The lined painting was attached to a stretcher frame.

The stretcher showed surface dirt, splinters, notches, and scratches. The reverse of the painting had heavy dirt accumulation, particularly dust and particles at the bottom of the lining, between the canvas and stretcher, and on the right half.

The lining canvas was oxidized, with yellowish stains and white drops (likely filler) on the back. Significant damage included insect holes and areas eaten through, affecting the original canvas, mostly at the top.

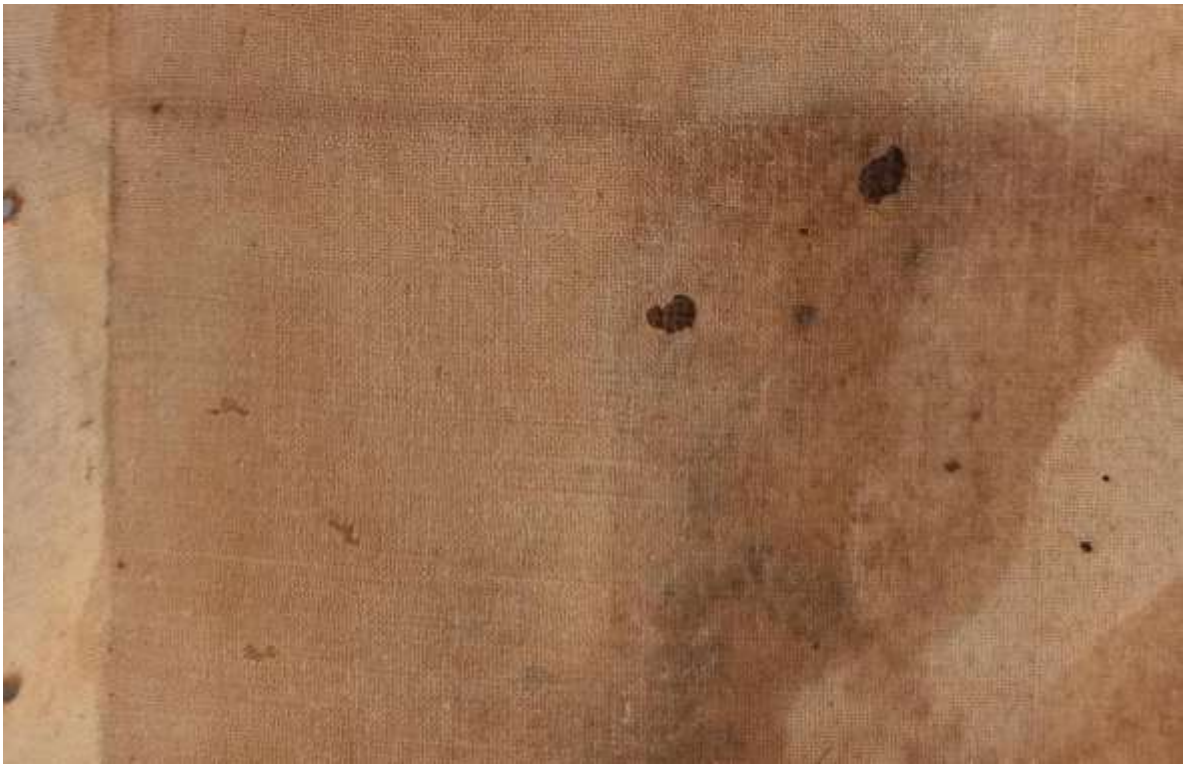

Figure no. 6: Saint Andrew by Stefani Erardi, Lining Canvas with Insect Infestation

Using Ultraviolet Radiation, many retouched areas were revealed, some visible even to the naked eye due to discoloration. Retouches often extended beyond original losses, sometimes covering the original paint, and some were applied without filling, creating an uneven surface. Many retouches were found both on top of and beneath the varnish, indicating the top varnish layer was not original and represented a previous intervention. The varnish appeared yellowed with age, with residues of an older varnish layer remaining between thicker brushstrokes. The paint layer showed signs of lifting or flaking, possibly consolidated by lining; however, the lining canvas no longer provided adequate support, as evidenced by widespread craquelure and cupping across the surface.

3.3.2.3 Treatment Proposal

In the same way as in the first case study, three treatment proposals were presented: a minimal, an intermediate, and a full treatment.

As mentioned in the condition assessment, the current lining does not offer the needed support to the painting anymore, which is evident by the recurrence of cupping and flaking in the paint layer.

Due to this failure of the lining and the general poor condition and quality of the lining canvas, a complete treatment was needed to ensure the stability and safety of the original material, and it was decided to remove the existing lining canvas and as much of the lining adhesive as possible. The following decision on how to proceed would be based on the condition of the original canvas that would be uncovered after the removal of the lining canvas, and will be discussed in the following chapter. The treatment, not

regarding the lining, was similar to the other case study and consisted of the cleaning, filling, and retouching of the painting's surface.

Table no.3: Comparison between the two case studies regarding the treatment and decision-making

Aspect	Saint Thomas by Stefano Erardi	Saint Andrew by Stefano Erardi
Original Canvas	Covered by lining canvas; not visible due to lining	Partially visible, exposed in small areas due to damage
Lining Canvas	Jute (assumed), with irregular shape and thickness, handmade	Plain-woven, possibly cotton, tightpattern, mechanically made
Lining Adhesive	Glue-paste (flour and animal glue mixture)	Glue-paste (flour and animal glue mixture)
Lining Condition	Good structural condition, no biodegradation; some stains and dirt	Insect damage, yellow stains, holes, some eaten-away areas
Lining Support	Still providing adequate support	No longer providing sufficient support (cupping and flaking)
Surface Dirt	Dust, spider webs, and surface dirt, especially in corners	Accumulated dust, particularly around the bottom and edges
Varnish	Yellowed, evidence of past retouches and interventions	Yellowed, retouches visible, and non-original varnish layer
Craquelure and Paint Condition	Stable craquelure, some abrasions and paint thinning	Cupping and flaking, indicating degradation of paint laye
Tacks and Strainer	Corroded tacks, strainer adhered to the lining causing deformations	Stretcher frame damaged with splinters, notches, and scratches
Past Interventions	Overpaints on face, hands, and background, especially skin tones	Retouches mostly covering original losses, some beneath varnish
Lining Seams	Vertical and horizontal seams visible on the front of the painting	No seams
Current Treatment Proposal	No removal of lining; intermediate treatment to improve aesthetic state	Full treatment with delining and new support via Mist-Lining
Challenges Identified	Aesthetic concerns due to seams, no major structural risk	Structural instability due to failed lining, insect damage
Delining Proposal	Not recommended due to potential risk to original material	Delining and new support proposed due to deteriorated lining
Treatment Process	No delining, minor aesthetic improvements	Removal of lining, consolidation of original canvas, new Mist-Lining
Potential Risks of Lining	Low risk of failure, stable canvas and lining	High risk due to fragile and deteriorated original canvas
Recommended Lining Treatment	Maintain current lining material as it is still functional	Mist-Lining technique (low-pressure, minimal adhesive use)
Condition of Original Canvas	Imprints and abrasions visible, no degradation	Highly fragile, brittle fibers, showing significant deterioration

3.3.2.4 Treatment of the Lining

Firstly, the fragile areas of the painted surface were protected with a facing done with the use of Japanese paper and gelatine. The wooden frame and the stretcher frame were removed in order to access the lining canvas. Furthermore, the lining canvas was being removed mechanically by slowly and carefully pulling off the canvas in ca. 10 cm strips to gain more control over the action. The strips were pulled off at a very horizontal angle to lower the risk of damaging the underlying original canvas as much as possible. This process was found to be very easy, which underlined the brittleness and therefore the degradation of the glue-paste adhesive, making it impossible to offer any support to the original. The next step was the removal of the Glue-Paste adhesive, which was carried out mechanically with a scalpel by scraping off the thick layer of glue in the direction of the threads. In order to lower the risk of damaging the fibers of the original canvas, not all the residues of the glue-paste were removed completely. The residues in between the threads are visible by micro-observation. However, insisting too much and removing more of the glue might damage the fibers.

Figure no. 7a: Saint Andrew by Stefano Erardi, Removal of Lining Canvas

Figure no. 7b: Saint Andrew by Stefani Erardi, Removal of Lining Canvas

After this process, the old filling material in the losses and especially around the edges of the painting was removed as it would be too weak to hold when being restretched onto the new stretcher frame.

Now the condition of the original canvas could be observed and assessed. It was found to be very deteriorated by aging, and the fibers were extremely brittle and therefore in a highly fragile state. This leads to the assumption that the original canvas is unable to support the layers of paint and ground sufficiently, and an alternative had to be found for further protection of the original material.

That process was started with preliminary treatments, such as the treatment of the cupping and deformation by the controlled use of moisture and pressure using a low-pressure vacuum table. Followed by the local consolidation of the flaking paint with gelatine. After that, the facing could be removed, and a tear in the center of the painting was being mended with Paraloid B72 threads, which could be placed inside the tear and then melted with a hot iron with a pointed tip for precision and in that way attached to the sides of the tear to create butt joints for strong support. For the next step, all the losses in the original canvas were filled with inlays made of linen canvas and fixed with Plextol. Some areas, especially around the edges, where the canvas needs to withstand high tension during the restretching, were further stabilized with polyester threads fixated with Plextol.

Figure no. 8: Saint Andrew by Stefano Erardi, Tear Mending with Paraloid B72 Thread

After completing the preliminary treatments, it was decided to go for a new lining in order to achieve better support for the original painting. However, a traditional lining would be considered too invasive, introducing too much adhesive and using too critical an amount of heat and pressure, and not offering satisfactory removability. That led to finding an alternative solution, which turned out to be the Mist-Lining technique.

As already mentioned, that technique offers a rather non-invasive approach by eliminating the use of heat and decreasing the amount of pressure and adhesive used for the process. The nap-bond system, which is only applied onto the lining canvas, offers lower penetration into the material and therefore a lower risk of impregnation, and also improves the removability of the lining material. For the Mist-Lining technique, first, the linen canvas was prepared by washing and attaching it to an adjustable metal stretcher frame. Then the surface of the canvas had to be “fluffed” to create the raised fibers that are needed to form the nap-bonds. The canvas was being treated with sandpaper until the fluff could be removed from the surface, and the raised fibers were left. Then the reverse of the lining canvas was being sized with 8% Plextol in water. After drying, the lining adhesive could be applied to the lining canvas. That was done with a spray gun with a wide opening and pure Plextol B500. The Plextol B500 was chosen due to its Tg and therefore suitability in humid and warm climates such as in Malta. The suitability of Plextol B500 for the Mediterranean climate has been studied and confirmed by the research of Antonio Iaccarino Idelson and Valerio Garofalo [Idelson, Garofalo, 2019]. It is also the preferred option at the Heritage Malta Conservation Laboratory and is readily available.

Figure no. 9: Saint Andrew by Stefano Erardi, Mist Lining with Plextol B500

The Plextol B500 was being sprayed onto the surface of the lining canvas from four different angles to embed the raised fibres with adhesive without lowering them. In that way the raised embedded fibres are able to create the nap-bonds. After drying, the lining process begins. A low-pressure vacuum table is used with first a cloth wettened with Xylene to activate the Plextol B500. On top of the cloth the lining canvas is placed with the painting on top of that. This construction of layers is put under low pressure until dry to achieve a satisfactory bond between lining and original. With that the lining process was completed and the painting could be treated further.

4

CONCLUSION

The exploration of glue-paste linings, their inherent challenges, and the search for less invasive alternatives highlights the complexities of art conservation. This dissertation demonstrates the necessity of balancing effective intervention with the ethical imperative to preserve the material and historical authenticity of artworks.

Traditional glue-paste linings, while historically prevalent, present significant challenges, including material degradation, irreversible alteration of the original canvas, and risks associated with their invasive nature. The ethical issues these challenges raise underscore the importance of transitioning toward innovative conservation techniques that align with contemporary principles of minimal intervention, reversibility, and respect for the original materials.

This dissertation focuses on the Mist-Lining technique as a promising alternative to traditional methods. By utilizing acrylic adhesives like Plextol, applied as a fine mist to create a nap-bond system, Mist-Lining minimizes adhesive use, avoids excessive heat and pressure, and improves the overall reversibility of the treatment. This approach represents a significant advancement in reducing the invasiveness of lining treatments while ensuring long-term structural stability.

The case studies of Stefano Erardi's *Saint Thomas* and *Saint Andrew* paintings underscore the practical application of these principles:

- **Saint Thomas**: The painting's general stability and the aesthetic concerns related to the jute lining led to the decision to retain the existing lining. This choice reflects a deliberate ethical approach, prioritizing the preservation of original materials and minimizing unnecessary interventions, even when faced with aesthetic imperfections.
- **Saint Andrew**: In this case, the degraded lining no longer supported the painting, resulting in structural instability. The ethical decision to remove the failing lining and replace it with a Mist-Lining treatment was informed by the painting's critical needs and the long-term preservation goals. The process was meticulously planned to minimize risk, protect the original paint layer, and ensure the compatibility and reversibility of the new materials.

These case studies exemplify how ethical considerations guide every decision in art conservation, balancing intervention with the imperative to protect the integrity of cultural heritage. They highlight the field's shift towards approaches that prioritize stability, reversibility, and the respect for an artwork's historical authenticity.

Ultimately, this dissertation advocates for the continued evolution of conservation practices, supported by research and innovation, to enhance our ability to safeguard cultural heritage. By embracing contemporary techniques and maintaining an ethical framework, conservators ensure that the aesthetic, historical, and cultural significance of artworks endure for future generations. This ongoing commitment reinforces the vital role of conservation in preserving the legacy of human creativity and expression.

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Appendix

Conservation Treatment Report – Saint Thomas by Stefano Erardi

Description

The painting presented a dark-coloured background with a figure as the main character in the centre. The figure was an aged man with gray hair and beard, and his face was directed to the right side. He wore a robe that was half yellow and half green. In one of his hands, he held a paper with a geometrical drawing, and in the other hand, he held a pair of dividers. These attributes assigned the man as St. Thomas the Apostle and the patron of builders and carpenters. The painting presented a strong contrast between light and dark. The use of chiaroscuro was typical for the estimated time of creation, which was during the 17th century. The painting is attributed to the Maltese artist Stefano Erardi (1630- 1716) and is a part of a series of paintings, all picturing the different Apostles.

Support

Manufacturing Technique

The auxiliary frame consisted of a wooden strainer frame with a simple mortise. The edges were unbeveled, and the joints were fixated with two metal nails for each joint. The seemingly mechanical manufacturing technique of the strainer suggested a later addition to the painting.

The lined canvas and strainer were marked with the letters "VR," which stood for "Victoria Regina" and came from the time of British colonialism. That also indicated that the painting was owned by the state, forming part of the national collection and was possibly once placed in the Grand Master's Palace in Valletta.

There were other labels to be found that indicated that the artwork was moved to different offices and ministries.

One label covering the lower left corner of the decorative frame and the joint of the strainer said "Office of the Prime Minister Malta" and "19|2," which could be the date.

Another label positioned on the bottom part of the strainer presented a writing that probably meant "Ministry of Foreign Accounts [?] 373 Malta AUG 1987" and another one next to it showed "Museum 2/72," meaning that it was part of the Museums' Department.

A label on the lower right corner of the decorative frame said "MFA RM102 NOV 2000 3602 0001," which probably stood for the Ministry of Foreign Affairs.

Additionally, the upper right part of the frame and the strainer were marked in black with "R.7 – N.84," and on the left "3065 FAS | P | 6/6."

Previous Interventions

The original support of the painting was covered by the lining material, and the original margins had been cut around the painted area of the canvas. The painting had been lined to a course plain-woven canvas consisting of three pieces of canvas sewn together. The Baxter Thread Counting Method on the lining canvas showed a result of 8 threads per cm horizontally and 9 threads per cm vertically. The lining

had a vertical seam covering the full height of the painting and was situated on the left side of the painting when looking from the back. This smaller piece of canvas on the left had a horizontal seam connecting the upper third part of the canvas with the bottom piece. The threads of the lining canvas presented an irregular shape and thickness with a loose pattern, suggesting a handmade origin. The margins of the lined canvas were not painted but had been cut behind the tacks. The tacks consisted of highly corroded metal tacks nailed into the strainer and bent to hold the canvas in place. In the upper margin of the lined canvas, additional holes for tacks could be observed.
Due to the information on the most commonly used fibers for lining at that time, the lining canvas was considered to be jute. The expected time of intervention was during the 20th century.
The lining adhesive consisted of a brown material, and due to the flexibility of the materials, it was most likely a glue-paste lining adhesive based on a mixture of flour and animal glue.

State of Conservation

The lining canvas presented a great amount of surface dirt, especially in the corners and the lower half of the painting. The main components of the dirt seemed to be dust and spider webs.
The lining canvas showed a big vertical stain probably due to water damage. Other darker discolorations were to be seen in the lining material.
Additionally, three spots were covered with a white filling material.
The original canvas was completely covered and could not be inspected without the removal of the lining. However, from the front of the painting, an imprint resulting from the pressure of the seams of the lining on the original canvas, while the texture of the canvas could be observed in the paint layer. The forceful imprint of the original canvas onto the front of the painting had further contributed to abrasions during past cleaning campaigns.
The margins of the lined canvas were presented in poor condition. They showed a great amount of surface dirt and dust in between the canvas and the strainer, while the strainer frame was adhered to the lining canvas. That and the unbevelled strainer has caused deformations in the canvas. Additionally, the tacks of the margins were highly corroded, which also affected the material of the canvas. The strainer presented a great amount of surface dirt, splinters, notches, and some spots of insect exit holes.

Paint Layers

Manufacturing Technique

The supporting canvas was coated with a dark red ground layer. According to the known information about the artists, one could assume that he used a double-ground system; he covered the canvas first with an ochre ground and additionally with a dark red oil-bound *imprimatura* on top.
The artist was meticulous in the way he applied the paint layer, covering most if not all of the red ground. This contrasted with other 17th-century artists who used the dark ground layer as a middle tone while modeling the figures.
On top of the ground, oil-based paint was applied thinly in several layers. Firstly, the dark greenish-black background was painted, followed by the main theme of the Apostle St. Thomas. The contrast was gently modeled by the artist by using fine glazes, and eventually, the highlights were applied using strong brushwork and opaque white, giving it a light impasto. Especially in the hair, the yellow color, and the skin tone, the ductus was clearly visible. The highlights were applied with thick paint in spontaneous but detailed brushstrokes. The main colors present in this artwork were the dark color of

the background, the yellow and green colors or mixtures of the clothes, and the skin tone of the Apostle. Apart from that, brown, black, and white color were used.

Previous Interventions

Under Ultraviolet Radiation, the many retouched areas were made visible. There were many overpaints to be found all over the painting with an increased amount in the skin tone, like the face of the Apostle and his hands, and in the dark background. These reintegrations were not only applied locally but covered bigger areas than the original loss.

The texture of the canvas was clearly visible in some areas, which was a result of the use of high temperature and pressure during the lining process in past interventions. These interventions also contributed to the abrasion in the paint layer.

Additionally, the discoloration in some areas like the green, brown, and dark colors might be due to past interventions that interfered with the material of the paint or the varnish.

State of Conservation

The whole painting presented a pattern of craquelure, which seemed to be stable. The observation of past treatments and the condition of the paint layer, suggested a history of lifting or flaking which might have been consolidated by lining the whole painting. It was covered with surface dirt, and small holes were observed all over the surface. The many overpaints and reintegration indicated that the original paint layer presented many losses, especially in the areas of the dark background and in the skin tone of the face, the hands, and the neck of the Apostle.

The paint layer seemed to be thinned; the ground color was visible beneath the painted surface, and the canvas texture was clearly visible. As already mentioned, this could be due to the lining process and the accompanied exposure to heat and pressure.

Additionally, chemical damage could be observed in some areas. The dark color of the background seemed more whitish, and that might be due to the aging process.

Varnish

Manufacturing Technique

Under UV light, the varnish seemed to be evenly applied on the painting, and it showed a greenish fluorescence, which might suggest the composition of a natural resin varnish. However, scientific investigation needed to be carried out to identify the used materials.

Previous Interventions

There were retouches on top of the varnish to be seen, but also underneath. This indicated that the top layer of varnish was not original and was done as a previous intervention.

State of Conservation

The varnish seemed to be yellowed due to the aging process. There was evidence of an older layer of varnish which left residues in between the brushstrokes of the more thickly applied paint

Documentation

General front view of the Painting before Treatment	Painting under UV Light
	

Raking Light: Front view of the Painting before Treatment	General back view of the Painting before Treatment
	

Treatment Proposal

Considering the condition of the painting and especially the support, an intermediate intervention proposal was chosen. The stability and flexibility of the support was found to be sufficient so that a full treatment including the removal of the lining canvas and a potential relining process or alternative, was not necessary in this case. In that way, the painting was not going to be removed from its auxiliary frame and the lining canvas was not going to be treated. That minimises the stress for the painting during a labour-intensive, and moisture-containing treatment and lowers the risk of damages.

The intermediate intervention assesses the urgent conservational treatments to insure the current stability of the artwork. Additionally, the aesthetic state of the painting is addressed in order to regain the artist's presumably intended appearance of the artwork and its aesthetic and artistic value. In that way, visible old interventions and altered materials such as overpaints, retouches and yellowed varnish would be removed and improved.
The estimated amount of time needed for the intermediate intervention would be between 2 – 4 months.

Treatment Steps

1. ***Surface Cleaning***
2. ***Varnish and Overpaint Removal***
3. ***(Consolidation if necessary)***
4. ***Infilling***
5. ***Isolation Varnish***
6. ***Retouching***
7. ***Final Varnish***

Conservation and Restoration Intervention

Surface Cleaning

In order to gain full accessibility to the paint layer, the decorative frame has been removed prior to the intervention.
The first step of the intervention is the surface cleaning. That step ensures the preservation of the painting by removing the surface dirt. The layer of dust that had accumulated over the years on the painting's surface presents a danger to the material. It makes it more accessible to microbiological attack as well as it lowers the aesthetic value and the readability of the artwork.
The method and the materials used for the surface cleaning need to be chosen carefully in order to present efficient and convincing dirt removal properties without effecting any other layers of the painting.
To assess the properties of the painting's surface, the pH and the conductivity was tested. The tests were carried out by using a water-based gel with Agarose that was put on the surface and measured. The purpose of this test was to identify the quantity of dust on the surface and the degree of oxidation. The pH gives information about the level of oxidation of the varnish and in that way about the age of the varnish. The average of the measured pH in this painting was 5.1 which means it is oxidised, but it is not old enough to be the original varnish.
On the other hand, the conductivity gives information about the amount of dust. In this case the average is around 190.
In conclusion, the painted surface was cleaned by using deionised water that was modified to correspond with the pH and conductivity of the painting. Therefore, acetic acid and ammonia, were used dropwise to reach the same properties as the painting and limit the risk of swelling and di-protonation. In that way, the aqueous solution addressed only the surface dirt with the least possible effects on the layers underneath.

Progress of the Surface Cleaning

Varnish and Overpaint Removal

An aged varnish yellows over time due to the oxidation of the resins and oils. This phenomenon lowers the aesthetic value and can influence the readability of the painting. An original varnish can be seen as part of the history of the painting and therefore a removal of such must be ethically evaluated. However, in this case, the varnish could be identified as younger than the paint layer and thus cannot be original. The pH of the painted surface proves that the degree of oxidation cannot be compared to an original varnish from the 17th century.

For this reason, it is possible to remove the non-original varnish without further ethical considerations. Before starting this intervention, tests were carried out to identify the solubility parameters of the varnish. The desired result is to swell the varnish layer without effecting the paint layer underneath. The tests were started by using a non-polar aromatic solvent and gradually increasing polarity by adding an alcohol solvent on one hand, and ketone solvents in separate tests on the other hand. In that way the least aggressive solvent is used first followed by increasing the effectiveness slowly until a solvent or a solvent mixture is found that presents the most suitable properties while having the least possible effect on any layers underneath.

Eventually, a 1:2 mixture of White Spirit and Acetone was chosen. This mixture presented good varnish removal results with the least number of repetitions and no visible effects on the original paint layer. Some more recent overpaint was also removed during this step.

Varnish Removal Progress	Varnish Removal Test
	

By using this solvent mixture, a lot of the old varnish was being removed. However, it was not possible to remove all the residues and to gain a more homogeneous surface, an aqueous based gel containing citric acid in water at 0.5%, with a pH of 6 using DEA was made. The mixture was gelled with xanthan gum and emulsified with 5.5% benzyl alcohol. The gel was applied by brush and any residues were removed with deionised water with the pH of 6.

After gaining a more homogenous surface and removing most residues of the old varnish and some overpaint, the older oil-based overpaint was being addressed. Several aqueous based gels were tested until one was found to have the most satisfying results. A gel containing DTPA in water at 1% with the pH of 9 and 20% benzyl alcohol was used locally for the remaining retouches. Despite all testing, some of the old overpaint could not be removed and to lower the risk of damaging the original paint, no further cleaning was carried out.

Detail of the Face after Varnish and Overpaint Removal

Detail of the left Hand after Varnish and Overpaint Removal

Detail of the right Hand after Varnish and Overpaint Removal	Painting after the Removal of the Varnish and Overpaint
	

Infilling

Because no consolidation was needed, the following step was the infilling of the losses. The infilling of losses improves the physical and aesthetic properties of the painting and presents an important step in this treatment. Here, an aqueous-based adhesive with an inert bulking medium was chosen that consisted of gelatine in deionised water in a ratio of 1:7 and calcium carbonate. The adhesive presents strong adhesion, good consistency, easy handling properties and the possibility of modelling and carving. The stucco was applied liquid, drop-wise with a fine brush and as locally as possible. Afterwards, the overlapping stucco was removed with a scalpel or a wettened cotton swap. The levelled fills were then textured by using the scalpel and dentist tools in order to imitate the texture of the original and make the infilling less visible.

Detail of the textured infilling	Detail of the infilling imitating the craquelure
	

Detail of the Head after Infilling

Painting after Infilling

Isolation Varnish

The next step of the treatment was the application of an isolation varnish. An isolation varnish reduced the absorbency of the infilling and the interaction with the retouching media. Furthermore, it builds a barrier between the original paint and the retouching, protects the paint layer and saturates the surface which is an important factor for the following retouching. The isolation varnish must be different from the original paint layer in order to be able to remove the varnish without effecting the layer underneath. The varnish should be different from the retouching medium as well to lower the risk of interference.
The painting was first varnished using Laropal A81 (40g) in Xylene (80ml) and White Spirit (120ml) in a ratio of 2:3 and 0.8g of Tinuvin was added to lower the degree of yellowing. It was applied by brush with first vertically and then horizontally brush strokes while the painting was being placed flat on a table. The paint layer absorbs a big amount of the varnish due to the nature of the colours that were used. Because of that, a second varnish was needed to decrease the absorption of the retouching colours.
The second varnish consist of 13% Paraloid B72 in Xylene and was applied twice, because some areas absorbed more varnish and in some of the cuppings the varnish accumulated and created an inhomogeneous surface. The Paraloid varnish was suitable for the following retouching process, because a Laropal-based retouching medium was chosen.

Detail of the pointillist retouching of the Nose

Retouching

Retouching a painting is one of the most important steps in conserving the aesthetic value of an artwork. The medium chosen for retouching should have suitable optical properties, optimal colour stability, and importantly it should be different from the original in order the be able to safely remove the retouching without risking damaging the original paint underneath.

Because of these aimed properties, an urea aldehyde resin known as Laropal A81 was chosen as the retouching medium. They are available as already mixed and ready-to-use colours called “Gamblin Conservation Colors” and present good photochemical stability and working properties.

The painting was retouched mostly using a pointillist technique and a mimetic technique for smaller-sized losses. The aim of this technique is to chromatically push back the losses in the paint layer and reduce their visual presence. Additionally, discoloured overpaint that could not be removed was being reintegrated with that technique as well.

The reintegration aimed to respect the original material. No original paint must be covered or interfered with. The retouching is done only locally without trying to disguise the natural ageing process of a painting. Hence, the losses were integrated using the pointillist technique in order to be visible by the naked eye. On the other hand, any alterations in the craquelure and abrasion were kept to a minimum or not treated at all.

The Gamblin Conservation Colors were diluted with Methoxy-Propan-2-ol and locally some Laropal A81 varnish was being used the check the appearance of the retouching.

Detail of the left Hand after Retouching

Detail of the lower left corner after Retouching

Detail of the right Hand after Retouching	Detail of the Face after Retouching
	

Final Varnish

After finishing the retouching, the painting was spray varnished using 20% Laropal A81 in Xylene and White Spirit in a ratio of 2:3 with 2.8g of Tinuvin. This procedure was being repeated.

When the procedure was done, minor retouches were being corrected that changed due to the application of the varnish. Additionally, some matte areas were being corrected locally with the Laropal A81 varnish.

The last step of the treatment of the painting, was the final varnish using 20% Laropal A81 with Xylene and White Spirit (2:3), Tinuvin and a small proportion of Microcrystalline wax (Cosmoloid H80). The wax reduces the glossy appearance of the varnish and therefore creates a more homogeneous surface and reduces the visibility of deformations. Additionally, the wax increases the Tg of the varnish which makes it less accessible for the attraction of dust.

Front View of the Painting after Treatment

Conservation Treatment Report – Saint Andrew by Stefano Erardi

Description

The painting was created by the Maltese artist Stefano Erardi and is part of a set of paintings featuring the Apostles. This piece of the series is picturing the Apostle St. Andrew. He is shown as an aged man with a long grey beard wearing an orange-brown garment and carrying a big cross while his face is directed to the left side. The man can be identified as the Apostle St. Andrew because if his typical attributes: the long beard and the cross he was hanged on. The figure of the Apostle is kept in earthly colours, while the main focus lies on the much brighter face and beard. That stands in a dramatic contrast to the dark background. The use of chiaroscuro is typical for the estimated time of creation which is during the 17th century.

	
Front of Saint Andrew	Back of Saint Andrew

Support

Manufacturing Technique

The support of this painting consisted of a wooden stretcher frame with a simple mortise as the auxiliary frame. The stretcher frame exhibited all stretching bars which were two per corner and the

edges of the frame were bevelled. The auxiliary frame seemed to be mechanically manufactured and therefore a later addition to the painting is suggested.

The original canvas could not be observed from the reverse as it was covered by a lining canvas. Only in small areas were the lining canvas presented losses, the original canvas was visible. In these areas, the original canvas appeared to be a course plain-woven canvas with a loose pattern.

Additionally, the edges of the painting were covered by a wooden construction framing the painting that has been fixated with metal nails.

The stretcher frame presented different labels and inscriptions covering the upper part of the frame. One label on the right side wrote “Ministry of Foreign Affairs Account 376 AUG 1987 Malta” with another label next to it that said “Museum” which means that the painting was coming from the Museum Department, so it belongs to the National Collection.

Additionally to these labels were multiple numbers written, including “3121-2 FAS/P/642”.

Previous Interventions

The painting has been lined to a plain-woven canvas possibly made of cotton, scientific investigation would be needed to confirm. The lining canvas is very thin, had a beige colour and the threads presented a regular shape and thickness with a very tight pattern, suggesting a mechanical manufacturing technique. The Baxter Thread Counting Method on the lining canvas showed a result of 26 threads per cm horizontally and 23 threads per cm vertically.

Due to the information on the commonly used adhesives for lining a canvas, the lining adhesive was assumed to be protein-based. A glue-paste lining based on a mixture of flour and animal glue.

The lined painting seemed to be attached onto to stretcher frame.

State of Conservation

The stretcher frame could be observed to have a great amount of surface dirt, splinters, notches and scratches. There are splits and joints have been nailed in -> can’t function as a stretcher frame.
The surface of the reverse of the painting presented a great amount of dirt, especially accumulated dust and particles at the bottom of the lining, in between the canvas and the stretcher frame and on the right half of the canvas.

Additionally, the lining canvas is oxidised, presented yellowish stains all over the backside of the painting and white drops which could have been some kind of filling material.

A great concern in the condition of the lining canvas was the appearance of insect holes as well as areas that were completely eaten away even affecting the original canvas underneath. These areas appeared all over the canvas, but mostly at the top.

Lining Canvas with Insect Infestation

Despite from these areas, the original canvas and the tacking margins were completely covered and could not be observed without the removal of the wood construction and the lining canvas.

Paint Layers

Manufacturing Technique

The original canvas was coated with a dark red ground layer. According to the known information about the artists, one could assume that he used a double-ground system; he covered the canvas first with an ochre ground and additionally with a dark red oil-bound imprimatura on top.

The artist was meticulous in the way he applied the paint layer, covering most if not all of the red ground. This contrasted with other 17th-century artists who used the dark ground layer as a middle tone while modelling the figures.
On top of the ground, oil-based paint was applied in several layers. It seemed like the artist first applied a brown medium dark colour on top of the imprimatura that shows through in several places, followed by the medium colours like brown, orange and red. These colours are mainly present in the main theme of the painting: the Apostle St. Andrew. On top of these colours, the artist carefully built up the contrast and the three-dimensionality adding brighter colours and finally the highlights with fine brushstrokes and giving it a light impasto. Here, the ductus was clearly visible.

Afterwards, the dark colour of the background has been added and used to frame the main theme and for the shadows that bring depth into the painted scene.

The main colours present in this artwork were the dark background, earth colours like browns and yellows for the clothes and the cross, and the grey and white colours creating the beard of the Apostle.

Previous Interventions

With the use of Ultraviolet Radiation, the many retouched areas are made visible, but can even be observed by the naked eye due to their discolouration. Many retouches seemed to not only be localised on the original loss, but also covering the original paint. Some losses were retouched without being filled which created an inhomogeneous surface.

A label has been attached to the bottom right corner of the painting with the number 13 on it.

State of Conservation

The observation of the condition of the paint layer suggested a history of lifting or flaking which might have been consolidated by lining the whole painting.

However, the lining canvas did not offer the needed support anymore, which was evident by the pattern of craquelure with great amount of cupping that occurred all over the painted surface. Most of the paint layer seemed to be stable except towards the bottom of the painting. Here, more dramatic and fragile cupping could be found that needed treatment. Additionally, a large number of losses in the paint layer was found in the same area that gave view of the canvas underneath. A smaller number of losses could be observed all over the painting.

Saint Andrew: Craquelure

Additionally, chemical alteration could be observed in some areas. Especially the area around the head of the Apostle stood out with a cloudy, whitened appearance.

Another assumption is the alteration of the texture in several areas, as in the orange sleeve of the garment.

Metal soaps, because of lead red.

Varnish

Manufacturing Technique

Under raking light, the varnish seemed to be blotchy. In some areas the varnish showed a greenish fluorescence under UV light, which might suggest the composition of a natural resin varnish. However, scientific investigation needed to be carried out to identify the used materials.

Previous Interventions

Many retouches were found to be on top of the varnish, but also underneath. This indicated that the top layer of varnish was not original and was done as a previous intervention.

State of Conservation

The varnish seemed to be yellowed due to the aging process. There was evidence of an older layer of varnish which left residues in between the brushstrokes of the more thickly applied paint.

Conservation Restoration Intervention

Cleaning of the Backside

Before addressing the painting's front surface, the backside was cleaned to remove accumulated dust and debris. The cleaning was carried out dry using a vacuum cleaner and a soft brush to gently dislodge and collect the dirt without damaging the canvas.

Surface Cleaning

The surface cleaning was conducted using modified distilled water with adjusted properties: a pH of 5 and conductivity of approximately 200. This cleaning solution effectively removed surface dirt while

being mild enough to minimize any risk to the paint layers. A slight blooming was observed, but it was not concerning, as the varnish was slated for removal in subsequent steps.

Varnish and Overpaint Removal

Initial tests were performed to determine the appropriate solvent mixture for varnish and overpaint removal, beginning with less aggressive solvents and gradually progressing to stronger ones.

After testing, a 1:1 mixture of MEK and Isopropanol was selected due to its effective removal properties while minimizing risk to the original paint layer. For stubborn residues, an aqueous gel was utilized to complete the varnish removal.

	
Cleaning Test	Cleaning Progress

Removal of Stretcher and Lining

The frame around the painting's margins and the stretcher were removed mechanically using a metal bar. The lining canvas was found to be weak and no longer offering adequate support, leading to cupping in the paint layer. The brittle glue-paste beneath the lining further necessitated its removal to properly address the cupping.

Removal of Lining and Glue

The lining canvas was carefully removed mechanically by slowly tearing off small pieces in a controlled manner to minimize risk to the painting. Residual glue was then scraped off using a scalpel, following the direction of the canvas threads. Though some glue remained in the weave, a compromise was made to avoid further thread damage. Additionally, the weak fillings at the edges were removed, and notches were infilled to level the canvas and prevent deformation during stretching.

	
Removal of the Lining Canvas	Removal of the Glue

Treatment of Cupping

The painting was treated on a vacuum table with a polyester cloth humidified with water. The painting was placed face-up, and vacuum pressure was applied to reduce the extent of cupping in the paint layer, restoring a more stable surface.

Consolidation

Local consolidation was performed using an 8% gelatin solution, the same material used in the initial facing of the painting, providing consistent support and strengthening to vulnerable areas.

Removal of the Facing

The facing material was removed by applying warm water with a sponge to soften the adhesive. The facing was gently pulled off horizontally, and any residues were cleaned using additional warm water.

Tear Mending

Tears in the canvas were mended using threads coated with Paraloid B72. These were heated to approximately 90°C and fused using a pointed-tip hot iron to create butt joints that restored continuity to the canvas.

Tear Mending

Inlays

Inlays were employed to fill larger areas of loss. Shapes were traced on Melinex and transferred to prepared linen canvas sized with 8% Plextol in water. The inlays were cut to match the traced shapes and adhered with Paraloid B72 threads or pure Plextol, ensuring stable integration with the original canvas.

Further Stabilization of Fragile Areas

Fragile areas were further stabilized by fixing polyester threads with pure Plextol, providing targeted reinforcement where necessary.

Preparation of Lining Canvas

A new linen lining canvas was prepared using an adjustable metal stretcher frame. The canvas was cut slightly larger than the stretcher, washed twice, and stretched. The surface was sanded lightly to create a fluffy nap, enhancing adhesion. An 8% Plextol solution in water was applied as a sizing layer.

Mist-Lining

The edges of the stretcher were covered, and a spray gun with a wide opening was used to apply Plextol B500 pure from multiple angles, creating a uniform nap bond. The canvas was allowed to dry completely. During lining, the painting and prepared lining canvas were placed on a vacuum table covered with a cloth soaked in Xylene to activate the adhesive. A low-pressure vacuum was then applied to secure the lining.

	
Mist Lining	Raised Fibres after Application of the Adhesive