Gilt leather conservation

A critical review to promote improved conservation strategies

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Title
Gilt leather conservation: a critical review to promote improved conservation strategies.

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Abstract:
Gilt leather is a decorative art form mainly used for wall hangings from the middle ages onwards. A leather support covered by thin silver leaves is coated with a yellow or orange-brown oil-resin varnish, providing the gold appearance. Further decorations are applied with various oil paints, glazes and varnishes. Complex ageing processes and the sensitivity of the specific layer build-up of organic and inorganic materials make conservation a real challenge. Conservation treatments practiced in the past resulted in negative side-effects over time, such as gloss and colour change (darkening), softening of the varnish and paint layers, and stiffening of the support. Gilt leather, of which only a fraction of the original output has survived, can be considered an overlooked and endangered part of our cultural heritage. Following an interdisciplinary expert meeting and research project (2016), this review discusses the most important conservation challenges, points out research directions and presents strategies for improved conservation treatments.

Keywords:
gilt leather, conservation, review, degradation

Introduction

Gilt leather was one of the most luxurious types of wall decoration in the Western world in the 16th to 18th centuries, used in high-status public buildings, palaces, stately homes and upper-class mansions. It has also been applied to folding screens, chairs and chests, and used for altar frontals and ecclesiastical vestments. Originating in North Africa (Ghadames, Libya), this craft spread in the late Middle Ages through Spain towards the rest of Europe, concentrating in centres as Cordoba, Venice, Malines, London and Amsterdam.

Gilt leather is created by adhering silver leaf to a leather structural support using animal glue, and covering this with a yellow or orange-brown oil-resin varnish. Further decoration is provided by embossing, punching with geometrical patterns, and additional oil painting in various colours, glazes and partial varnishes. This specific layering of materials has not been encountered elsewhere. It differs from well-known layer built-up of paintings, where the varnishes sit on top of the paints and glazes instead of the other way around. Due to its complex nature and sensitivity, conservation

of gilt leather is a real challenge. Curiously, little systematic analytical research has been undertaken on its degradation processes, or the effects of previous conservation treatments.

This review is an overview of the issues that we face in the conservation of gilt leather artefacts. It points to problems and difficulties encountered over the past decades, but also describes solutions and advances developed, illustrated with examples of recent conservation projects. Some strategies are proposed on how the conservation of gilt leather can be taken to a next level. The role of both research and inspections are being discussed, as is the importance of both technical art history and systematic analytical research of degradation processes. The importance of communication and knowledge dissemination is beyond all doubts and strongly underlined. Potential future projects are outlined.

This paper is the follow-up to a cross-disciplinary collaborative research project (2015-2016), funded by NICAS (Netherlands Institute for Conservation, Arts and Sciences). An interdisciplinary group of experts – with representatives from France, Germany, Belgium, England, Sweden, Denmark, Norway, Italy and Spain – was involved in developing a research agenda for gilt leather. The results are integrated in the publication *Gilt Leather Artefacts. White Paper on Material Characterization and Improved Conservation Strategies within NICAS* (Posthuma de Boer et al. 2016).

What are current issues in the conservation of gilt leather artefacts?

The problems that conservators face today are a combination of the effects of the fragility (aging) of the materials, past restorations and inappropriate climates. The most urgent and important conservation challenges are taking place both on structural and aesthetic levels: degrading hanging systems, inappropriate linings, darkening of later added varnishes, the effect of non-drying oil products (leather dressings and emulsions) into the decorative layers, damage to original gold lacquers by later solvent varnishing, corrosion of the silver leaf, degradation of the leather fibres, and unfavourable climatic conditions.

Structural conservation

Gilt leathers are rather complex to treat due to the hygroscopic behaviour and inhomogeneous nature of historic leathers. The fiber structure of aged leather is less compact due to hydrolyses and oxidation (depolymerization), resulting in increased water sorption and desorption in reaction to RH fluctuations of ambient air. The speed of sorption processes increases as well upon ageing, which increases mechanical stresses on the leather fibers. Sudden changes in RH are a high risk for leather (Larsen 2000). Aside from climate improvements, carefully chosen structural support and repair materials are crucial, as are flexible hanging systems allowing continuous shrinkage and expansion of large gilt leather surfaces.

Various hanging systems designed since the 1990's are using different ways of applying tension: flexible textiles (Van Soest), coil springs (Nimmo et al. 1996, Schulze 2004), extension springs, weights and gravity (Nijhoff Asser et al. 2014), or without tension (loose hanging leathers in Oranienbaum and Moritzburg Castle). Important questions

remain: How much does leather shrink and expand? How much tension can safely be applied? Which repair and support materials are compatible with the mechanical properties and hygroscopic behaviour of aged leathers?

The amount of shrinkage of gilt leather has been experimentally determined during several conservation projects. For different leathers this was in average 0,5% and 0,6% for a 40% RH change (Schulze, Nijhoff Asser, Nimmo et al.). However systematic tests on the hygroscopic behaviour of historic leathers still needs to be undertaken.

The mechanical properties of historic gilt leather have been studied. Tensile and yield strength tests on different types learned that the tensile strength varies substantially (4.5 – 7.5 Mpa, 4-20%) depending the type and condition of the leather, the orientation of the leather fibres, and the degree of tooling (punches) (Nimmo et al. 1996). Nijhoff Asser came to a similar range of results (3.2 – 8 MPa breaking load) by rudimentary tensile strength tests on 18th century gilt leather fragments (Nijhoff Asser et al. 2014) (figure 1). She indicates that for establishing safety margins for tensioning historical gilt leather wall hangings, additional mechanical testing is required (strength, elasticity and elongation) following the standard test methods for leather (ASTM). Nijhoff Asser developed a simple but effective monitoring system for registering the movements of gilt leather hangings in response to fluctuations in climatic conditions.

Repair and backing materials and adhesives have extensively been tested for both textile and objects conservation (Dignard 2013), but might not be directly transferable to gilt leather. Depending on the condition of the leather, the use of heat and moisture, and specifically the combination of these two, should be limited. Comparative testing has been done on adhesives (wheat starch paste, methyl hydroxyethyl cellulose, ethylene vinyl acetate and acrylic co-polymers) and support materials (Japanese paper, non-woven nylon fabric, alum tanned calf leather) (Iafrate et al. 2011). Mechanical properties of both materials and joints were obtained. Comparative studies for assessment of (strip) lining materials and adhesives are however lacking. Risk profiles of specific types of backing materials, adhesives and application techniques (heat, solvents or moisture) should promote safer conservation, both in short as in long term. Eventually this should result in a set of requirements for the development of adhesives suitable for gilt leather conservation.

Conservation of decorative surface layers

Within gilt leather conservation the decorative surfaces received little attention, compared to structural conservation. Often a strategy of minimal intervention is chosen because of a lack of knowledge of (advanced surface) cleaning techniques, and the possible effects on the materials of this composite layering. Very specific for gilt leather is the silver leaf and its associated corrosion. Research initiatives on this topic have only recently been started.

Corrosion of the silver leaf

Corrosion of the silver leaf is an irreversible process with detrimental effects on the aesthetic appearance of gilt leather. Silver tarnishing on gilt leathers often shows as a local darkening (brown, grey, green) or even blackening of the surface (figure 2 and 3). Tarnishing reactions occur due to contact with reduced-sulphur containing compounds

such as hydrogen or carbonyl sulphide in the air, or with elemental sulphur. Exposed to an environment containing chloride ions, such as in coastal regions or in exposure to human skin, it forms silver chloride. Tarnishing can appear quite early after production due to the presence of unbound tannins or acidic elements in the leather. It may also be caused by mechanical damage to the protective 'gold' varnish layer by punching, or similarly by natural ageing and degradation of the protecting layers, such as embrittlement and micro-cracking of the oil-resin varnish caused by light exposure, or by increased porosity of the animal glue underneath the silver leaf. Other possible causes are gaseous pollutants, light sensitivity of the silver, and the composition of organic layers applied during restorations (Talland et al. 1998, Schulze 2011). The possible negative effects of the widespread use of oils and waxes, almost a 'standard' restoration treatment in the past, has been indicated as well (Schulze 2011, Posthuma de Boer et al. 2016). Recent observations point to eventual reactions due to sulphur containing pigments, such as orpiment or vermilion (observations by Bianca van Velzen, SRAL, 2015). None of these factors influencing corrosion processes have been analysed systematically.

The first actual research project on this topic is CORD'ARGENT (Radepont et al. 2015). This concentrates on the rate of tarnishing processes as a function of specific characteristics of the silver leaf, such as elemental composition (depending on provenance), thickness (depending on manufacturing) and surface roughness (depending on burnishing during gilt leather production). In addition, the influence of restoration products on these processes is studied. The first results are expected in 2017.

Restoration recommendations for tarnished gilt leather are lacking. Due to the thinness of the silver leaf, the corrosion process will often have transformed the full silver layer. Preventive conservation is therefore of high importance, and should concentrate on creating guidelines for environmental circumstances. A better understanding of degradation phenomena and processes is essential to the development of (preventive) conservation measures.

Pictorial layers: oil resin varnish and oil paints

The oil-resin varnish that forms the shiny golden surface on the silver is composed of heat-bodied linseed oil with lead components (from pigments such as massicot or minium) to enhance drying properties, resins from different trees (e.g. sandarac, colophony) and fossils (e.g. amber), and organic colourants (e.g. aloe, asphalt, saffron, dragons blood etc.) (Schulze 2011). Little is known about the degradation processes of these varnishes. Frequently observed damages are a "bleaching" of the varnish and its colouring components caused by UV from daylight, and an increased porosity enabling silver tarnishing by hydrogen sulphide in the ambient air (Schulze 2011).

Gilt leathers have been painted with oil paints and glazes similar to those used for canvas and panel paintings. Traced pigments are amongst others lead white, chalk, earth pigments, yellow and red lead, arsenic pigments (orpiment), vermilion, blue and green copper containing pigments (verdigris, copper resinate), indigo, Prussian blue (18th century) and carbon black (Schulze 2011). Organic dyes and lakes, such as cochineal and madder, have been used extensively too. Historic sources indicate heat-bodied oils or oil-resin mixtures as a medium. Much research has been performed on the degradation

of pigments and binding media within the realm of painting conservation (Van Loon et al. 2012). Similar degradation can be encountered on gilt leathers, but have hardly been reported on specifically. Crack patterns typical for the paint layers on gilt leather have been reported (Moroz 1995, Schulze 2011). However, the entire variety of crack patterns is not as well understood as in paintings, and identification of the different patterns is desirable.

Past conservation treatments with oils have been cause for serious concern. Until the late 20th century within leather and book conservation, oil dressings (solvent as vehicle) or emulsions (water with a surfactant as vehicle) were used to lubricate and soften the leather. Unfortunately many gilt leathers have been 'oiled' as well, in some cases with disastrous effects. A softening and partial dissolving of the varnish and paint layers (figure 3) has been observed in various geographical locations (Göpfrich 1998, Schulze 2011, Posthuma de Boer et al. 2016). The hypothesis has been raised that oils applied at the verso side of gilt leather hangings migrate through the leather to the decorative finishes. As described earlier, silver tarnishing may be related to oiling, specifically in the case of sulphated oils (treated with concentrated sulphuric acid or sodium bisulphite).

In many cases, we have to accept the visual alterations caused by pigment and paint degradation; however, advanced surface cleaning techniques developed within paintings conservation for partial and selective cleaning of heavily yellowed non-original varnishes are promising. These can considerably improve the 'readability' and 'perception' of gilt leathers with strong discolouration and obscuring of formerly bright areas. The applicability of these techniques however needs to be carefully assessed, taking into consideration the 'solvent sensitivity' of the 'gold' varnish and coloured glazes, and the vulnerability of the silver leaf. Monitoring and damage assessment techniques need to be developed to ensure a safe application.

Important advances in (partial) removal of non-original varnishes have been made by Stichting Restauratie Atelier Limburg (SRAL) and involve a 'tissue-gel composite cleaning technique' (Fife et al. 2011). Thickened solvents (organic solvents gelled with cellulose ethers) were applied to painted surfaces with absorbing tissues restricting both solvents and dissolved products moving through the paint layers to the solvent sensitive oil-resin varnish and silver leaf underneath. This technique proved to be very successful in the pilot restoration of some gilt leather panels of the Venlo town hall (figure 4). A strongly discoloured non-original varnish was removed revealing the original green background colour. In another project conservators managed to locally thin the non-original varnish layers on top of the 'gold varnish' with careful solvent selection (figure 5). Extreme care was taken not to disturb the varnish and paint layering, as paint cross-sections showed that the original gold varnish had already been damaged by previous conservation treatments.

Prior to any conservation intervention, extensive examination of the composition and paint layering should be performed. Selective use of various varnishes for different paints and glazes on gilt leather is known from historical sources (Vermeulen et al.). Sometimes, the original surfaces including its varnishes might still be there, as SRAL recently discovered on the wall hangings of the Lenghenhofje in Dordrecht. Specific parts of the depicted birds and foliage are covered with a highly glossy coating, creating

a subtle play of light reflections. Art technological investigations of pristine and documented gilt leathers are needed, even as reconstructions of historical recipes. Knowledge on painterly subtleties is of paramount importance to decision-making on surface treatments.

How to advance the conservation of gilt leather artefacts?

Certainly, gilt leather conservation will greatly benefit from applied research into the mechanical properties and hygroscopic behavior, as from further mechanical testing of repair materials and adhesives, especially those used for strip linings. A safer use of specific solvent and water based adhesives, and of application techniques using heat, should be promoted by risk analyses. Recent pilot projects with the help of knowledgeable painting-conservators learn that advances can be made on the conservation of the decorative layers. Techniques to assess and monitor possible damage of partial and selective solvent cleaning to underlying gold varnish is needed to ensure responsible treatments.

There are many unknowns regarding degradation specific processes, as the corrosion of silver leaves and the effects of past conservation treatments with oils and solvents. Scientific research could improve the understanding of these degradation phenomena and help to develop (preventive) conservation measures and treatments. This will also clarify what damage or ageing is irreversible, and should be accepted as part of the patina of gilt leather.

Due to the ageing processes it is difficult, even for specialists in cultural heritage, to get an idea of the former splendour of gilt leathers. Further art technological investigations will lead to a better understanding of their original look and characteristics.

Awareness and knowledge dissemination

The vulnerability of gilt leather requires integrated approaches where risks of planned interventions for both the support and the decorative layers are assessed before actual conservation work is carried out. Unfortunately, only a select group of specialized conservators is aware of the scope of the various conservation issues and the risks involved in specific treatments. First and foremost a general awareness on the fragility is needed, as the essential (holistic) approach integrating both structural and surface treatments. Gilt leather conservation requires an interdisciplinary teamwork of specialized conservators. This needs to be directed towards owners, caretakers, architects, curators, art historians, and the conservator-restorers involved.

Recently the initiative has been taken to start a digital platform where the prime information on gilt leather is provided, its delicateness is highlighted, conservation routes are explained, and pitfalls are shown. A knowledge base will be built, including an illustrated glossary of condition (degradation), an overview of past conservation treatments, best practices and worst cases, general guidelines (recommendations) for (preventive) conservation, and selective literary sources.

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Figures

Figure 1:
Tensile strength tests on 18th century gilt leather fragments by Nijhoff Asser 2014.

Figure 2:
Detail of the gilt leather wall hanging (1768) of Pietershof Hoorn. (a) Brown areas around punch marks: a result of silver tarnishing. (b) Cross-section (SEM-BSE image) of an untarnished sample: white line indicates silver leaf. (c) A tarnished sample with remnants of silver leaf.

Figure 3:
A severely darkened gilt leather wall hanging (1783) in the orphanage in Schiedam. (a) Cross-section showing disturbed varnish layers, caused by the use of non-drying oils or solvents in earlier restorations (uv-fluorescence microscopy 200x).

Figure 4:
Pilot restoration of the gilt leather wall panels (1734) of the Venlo town hall, SRAL 2015. 'Tissue-gel composite cleaning' of strongly discoloured non-original varnishes. (a) During, (b) before and (c) after treatment.

Figure 5:
Pilot restoration of the gilt leather wall panels (1739) of the Maastricht town hall, SRAL 2015. (a) Before and (b) after surface treatment. (c) The darkening of the green paint (containing orpiment) and the silver leaf around it. (d) Cross-section showing distorted varnish layers, caused by non-drying oils or solvents applied during earlier restorations (uv-fluorescence microscopy).