Let's pretend. Conservation of an experimental tortoiseshell imitation

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Abstract

Tortoiseshell has been used as a decorative material in the arts since the beginning of written history. It has always been scarce and is therefore often imitated. Het Loo Palace in Apeldoorn, the Netherlands, has a cabinet from the 1840s in its collection with a rare imitation finish: it is not horn, nor is it one of the semi-synthetic plastics that were developed in the nineteenth century. Over time the finish had become dull, cracked, distorted and fragments had chipped off. In order to develop an appropriate treatment method, its composition and material properties had to be studied. It proved to be an experimental material made out of animal glue.

Introduction

Het Loo Palace was a residence of the Dutch royal family from the middle of the seventeenth century until the death of Queen Wilhelmina in 1962. In the 1980s it was turned into a museum of the Orange-Nassau family. One of the most extraordinary pieces from the collection is a silverware cabinet that is likely to have been bought by King William II and that was brought to Het Loo after his death by his son King William III.[1] The cabinet was made in the 1840s in revival style, combining elements of the Gothic and Baroque periods, most noticeable in the use of pinnacles, pierced columns and ripple mouldings (figure 1). The upper part of the cabinet is fitted with plate-glass windows with red silk curtains and mirror glass on the inside. The lower part has mirror glass on the front and sides. The imitation tortoiseshell is applied to the top gallery (now partly missing), the front, the sides and top of the lower part.

The cabinet is ascribed to Frederik Koster, a cabinetmaker from Utrecht, the Netherlands. It is a showpiece demonstrating the skills of a craftsman. It is known from an inventory that King William II bought a 'silverware cabinet, decorated with tortoiseshell and plate-glass' at an exhibition in 1847.[2] It was in this period that Koster acquired the title 'Royal Purveyor of tortoiseshell furniture'. Only a

Figure 1 The silverware cabinet before treatment. Photo: Het Loo Palace.

Figure 2 The pattern of craquelure.

few cabinetmakers in the Netherlands were able to work with this material at this time.[3] Paul Rem, curator of furniture at Het Loo Palace, further suggests that Koster used the imitation tortoiseshell to demonstrate his knowledge of the latest materials, where he could have also used horn, a traditional tortoiseshell imitation material.[4]

Condition

The imitation tortoiseshell is in a bad condition. It is dull, cracked, distorted, and fragments have chipped off (figure 2). Moreover, the material is brittle and therefore extremely vulnerable in the distorted areas. The damage is caused by the interplay of the material properties of the imitation material, the construction of the cabinet, and the conditions of storage. The imitation material is sensitive to fluctuations in relative humidity: it expands and contracts. It is glued to a wooden substrate that is also water-sensitive, but that expands and contracts at a different rate and in a different direction. The imitation is thus restricted in its dimensional change, which causes tension and, consequently, cracking.

The most common pattern of craquelure starts at the edges. The finest cracks are visible to the eye only as dullness, but as the material further deteriorates and repeatedly goes through cycles of shrinkage and expansion, small cracks appear. These are visible along all the edges and can, at their worst, run through the whole surface to the opposite edge. This process is accelerated by moisture acting on the increased surface area of the distorted areas. These areas can chip off easily, especially when brittle, making the substrate visible. In areas where the substrate cannot expand and contract because of construction, there is hardly any damage visible.

Another pattern of craquelure is the result of a conservation treatment in the 1990s. In 1993, the Cultural Heritage Agency of the Netherlands performed FTIR analysis on a sample and stated that it was composed of casein, starch, and a natural resin. It was 'possibly casein formaldehyde', but the research was 'not conclusive'.[5] At the time, the conservation of (semi-)synthetic materials was still in an early stage and it was therefore not possible to formulate a treatment methodology. An experiment was made to reconstruct the original appearance of the finish, but this resulted in new craquelure after a few weeks. It was decided to place the cabinet back in storage and wait for advancement in conservation science.

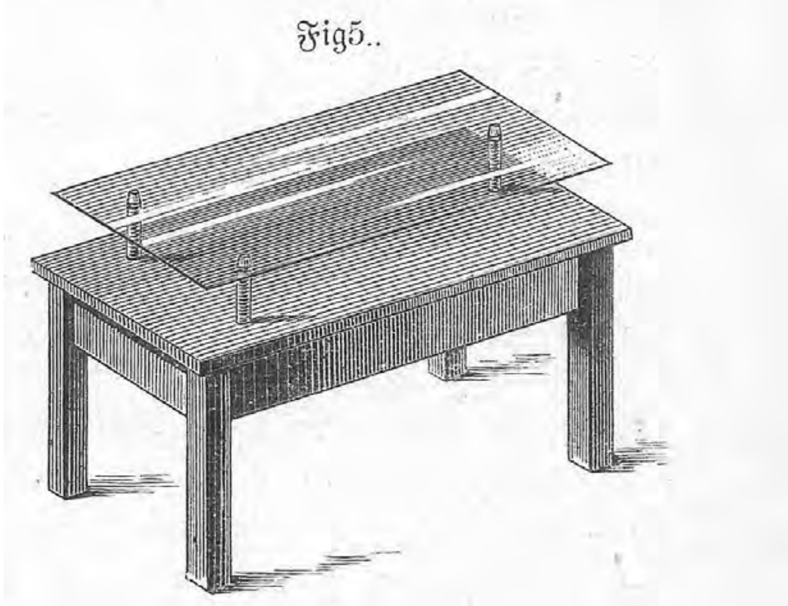

Figure 3 Table with horizontal glass plate. Source: Lehner 1883.

Identification: visual analysis

The FTIR analysis stated that the imitation material was made out of casein and might even be casein formaldehyde. The latter is not possible, since formaldehyde was only first synthesised in a laboratory in 1859 and the cabinet is from the 1840s. The first patents for casein formaldehyde only appear around the turn of the century.[6] The other semi-synthetic plastic from the nineteenth century, cellulose nitrate, was only commercially available after the 1860s. It also cannot be a natural material like horn, let alone tortoiseshell, because the imitation is water-sensitive and has a different pattern of craquelure. These characteristics seem to suggest a proteinaceous material, such as casein or gelatine.

The imitation tortoiseshell on the silverware cabinet has a thickness of 1 millimetre and is glued to the cabinet in sheets of equal size. The different sheets are butted against one another at regular intervals. A small sample of the imitation tortoiseshell was analysed under an optical microscope and showed a layer-wise build-up: two transparent layers, each one topped with a much thinner coloured band (figure 3). These characteristics seem to suggest a laborious process in which a plastic material was cast and dyed in different stages, resulting in relatively small sheets of imitation tortoiseshell.

Identification: historical source analysis

The author found hardly any literature on proteinaceous plastic materials published before the beginning of the twentieth century. There are, however, many nineteenth-century publications on casein or gelatine as a binding medium or glue.[7] A rare exception of literature on plastic materials is a French trade magazine from 1799 that describes

the process of wire netting, in which a sheet material is made by repeatedly dipping a wire mesh in gelatine, building it up layer by layer.[8] However, no contemporary publications were found.
The only nineteenth-century publication on proteinaceous plastics the author has found is Die Imitationen. Eine Anleitung zur Nachahmung von Natur- und Kunstprodukten (...) by the German chemist Sigmund Lehner. This title is part of the comprehensive Die Chemisch-Technische Bibliothek (volume 101), a practical book series on the latest developments in science and industry, published by A. Hartleben's Verlag in Vienna from 1875 to 1949. In Die Imitationen a process is described to imitate exotic materials like ivory, mother-of-pearl and tortoiseshell, using casein or gelatine.[9] This process was already outdated at the time of its first publication in 1883: 'In neuerer Zeit haben die Schildpatt-Imitationen aus Leimmasse an Werth verloren, indem man solche Imitationen weit dauerhafter unter Anwendung von Celluloid darstellen kan'.[10] By then, imitation tortoiseshell made out of cellulose nitrate was far more durable. The casting process described in Die Imitationen might well have been applied in the 1840s. Three components are needed for the imitation tortoiseshell: a binding medium, filler and pigment.[11] The binding medium, either casein or animal glue, has to be soluble in hot water, transparent and colourless. A filler like starch is added to increase transparency.[12] A mixture of binding medium and filler is cast on a glass plate which is fitted to a table with screws, allowing the plate to be levelled (fugure 4). Rulers have been placed on the sides and at one end to control the thickness of the casting. The surface is then evened out with a spatula, making excess material flow out on one side. When the plastic material has set, the mottled pattern of tortoiseshell is painted in with a brush. This process can be repeated to gain more depth. Afterwards the glass plate is placed in a warm room to dry and then placed in an oven to further reduce the moisture content.

In the last phase of the production process the imitation tortoiseshell is 'hardened' or cured in a water bath, making it less water sensitive.[13] It is in this respect that casein and gelatine casts seem to differ most from casein formaldehyde. A curing agent imparts crosslinking to the protein and it is very likely that the degree of crosslinking largely determines the durability of the final product. A solution of formaldehyde in water is mentioned in the 1884 edition of Die Imitationen as a curing agent too, but in the 1840s, only solutions of either tannin or alum could have been used, having been applied in the production of leather for centuries. The solution cannot be too high (higher than 4-5% for formaldehyde), as it will cure the surface before it can diffuse to the core.[14] If the concentration is too low the curing is incomplete or takes too long (up to months). This might well be the problem with both tannin and alum. However, there was no time within the research for comparative testing.

Identification: material analysis

New pyrolysis-GCMS analysis concluded that the imitation material was made out of gelatine and starch. A resin was not found in the second analysis or in the cross-section or solubility tests. The sample for the earlier analysis was probably taken from a section that had once been varnished to restore the level of gloss. The pyrolysis-GCMS analysis also excluded the presence of the organic curing agent of tannin. The inorganic curing agent of alum could have been analysed with FTIR, but there was no budget left within the research. It was therefore also not possible to use pyrolysis-GCMS again to determine whether the animal glue was derived from either hide or bone. The imitation material is made out of gelatine and starch with the likely addition of alum as a curing agent.

Aim

The silverware cabinet is one of the most extraordinary pieces in the collection of Het Loo Palace, which is a museum of the royal family that wants to display its furniture accordingly.[15] However, the tortoiseshell imitation is an experimental material. The craquelure is part of its natural ageing, its patina, as it simply is not durable. The new treatment will therefore differ from the 1990s treatment in that it will not try to restore the original appearance. The aim of the treatment is to prevent further deterioration and bring the cabinet back into aesthetic unity again by cleaning, consolidating, and reconstructing the finish with the conservation of craquelure.

Conservation literature

Since the early 1990s, there has been little progress in the conservation of proteinaceous plastics, as opposed to the other nineteenth-century plastics made out of vulcanised rubber and cellulose nitrate. Some studies concerning casein formaldehyde were made, but they did not result in a treatment methodology.[16] Kaner (2010) suggests that water can be used as a plasticizer to treat distorted parts, but it is not clear to what percentage it can be added or which technique is most effective.[17] A further comparison of various fields of conservation on the treatment of craquelure made clear that apart from water (with or without a thickening agent), heat is often used as a plasticizer.[18] Furthermore, there are some studies on the reconstruction of tortoiseshell, most notably by Williamson (2002).[19] He suggests various methods for imitations out of animal glue with a curing agent to obtain specific patterns or properties. Another method is using tortoiseshell imitations out of cellulose acetate.

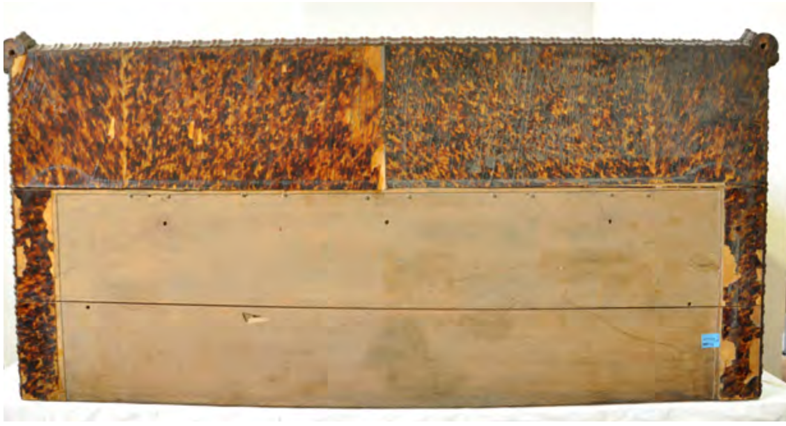

Figure 4 The left part of the top is consolidated.

Cleaning

The tortoiseshell imitation was gently cleaned with a microfibre cloth and, where needed, with cotton swabs dampened with Shellsol D40, as an aliphatic mineral spirit does not affect gelatine. This was sufficient to remove accretions of dirt.

Figure 5 Detail of top with reconstructions.

Consolidation

The craquelure caused by the conservation treatment in the 1990s was traced on a sheet of Melinex. It showed that the surface had been stable during a period of about twenty years after the initial damage. It was hypothesised that the problem might not be the plasticizer itself, but the amount of added water. A modification to the amount of water could determine whether or not new damage would occur. The water could be reduced considerately, since it was only needed to treat distorted areas, not to swell the gelatine and restore the original appearance. After some tests on gelatine casts, a new test was done in a discreet area.

As a first test, a mixture of demineralised water and ethanol (1:1) was applied with a syringe. The ethanol was added to lower the surface tension, enabling the water to flow in between the finish and the substrate. After five minutes, the plasticity was tested with light finger pressure; the material had lost most of its tension. This technique, however, did not work in more strongly distorted areas. During further testing for these areas a cotton swab moistened with the mixture of water and ethanol was placed underneath the flake, or a thin layer of fish glue was brushed on its backside, depending on the degree of distortion. These techniques seemed to work. Afterwards, the swabs were removed with a tweezer and the glue with a slightly dampened microfibre cloth. The treated area was traced on a sheet of Melinex before the experiment; after a month it showed no further deterioration.

Then, testing was done to choose the best consolidant. The consolidant had to have a low viscosity

Figure 6 The top is saturated.

for easy penetration, good adhesion, some elasticity to allow for dimensional change, and had to be reversible. The solvent-based acrylates Paraloid B67 and B72 proved inadequate because of their long curing time and poor adhesion. It seemed that the consolidant also needed some water to plasticise the distorted areas. Further testing showed that a mixture of fish and hide glue (1:1) worked best. It is a thin glue that is liquid at room temperature, remains flexible, and contains a relatively low percentage of water.

The distorted parts of the imitation tortoiseshell were plasticised with a mixture of water and ethanol and consolidated with a mixture of fish and hide glue. The surface was then clamped with acrylic sheets. The clamps were temporarily removed in order to wipe off the excess glue with a slightly dampened microfibre cloth. The surface was then clamped for 24 hours and cleaned again (figure 4).

Reconstruction

The appearance of the imitation tortoiseshell had to be approximated in colour, transparency, and gloss. Research into commercially-available tortoiseshell imitations showed that the matching patterns and colours were not available. Tests were done with animal glue casts, but their long-term stability was unknown. Epoxy was chosen as a casting material because it is durable, it is not sensitive to moisture, and it dries quickly without the inclusion of air bubbles. A commercial epoxy was used.[20] It will yellow over time, as do most epoxies, but the original tortoiseshell is yellow in colour too. Moreover, the inserts can be removed since they are cast separately from the object and adhered with a reversible glue. The inserts have been documented.

The film was cast on a glass plate lightly powdered with talc and the mottled pattern was painted in with epoxy pigments that were thinned down with epoxy resin. The result was an imitation with a general match in colour and pattern, allowing for further adjustment in specific areas. The film was then scraped, sanded and sawn to fit the missing areas. Small cuts were also made with a fretsaw to imitate craquelure. If needed, the colour was adjusted by staining the adherent with Orasol stain. The pattern was adjusted by brushing Golden acrylic paint on the backside of the inserts. A mixture of fish and hide glue was used to put the inserts in place. An even gloss was obtained by saturating dull areas and small craquelure with a low molecular weight varnish. The low molecular weight varnishes have relatively short polymer chains, allowing for deep penetration.[21] A solution of the urea-aldehyde resin Laropal A81 (20%) was used in a mixture of the hydrocarbon solvents Shellsol T (aliphatic) and Shellsol A (aromatic) in a 2:1 ratio. It was brushed on and repeated once. A stronger solution (40%) was used to fill the remaining craquelure, since the substrate was saturated but the cracks were not (figure 6).

Conclusion

The cabinet is finished with a rare imitation tortoiseshell made of natural glue that was probably treated with the hardening agent alum. The material is part of an early phase of the development of the relatively durable semi-synthetic casein formaldehyde, and no other examples of this imitation material are as of yet known. The imitation is experimental in nature, making the craquelure an ageing characteristic of the material.

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Notes

[1] Rem 2003: 81.
[2] Rem 2003: 80.
[3] Van Voorst tot Voorst 1992: 464.
[4] Conversation with curator Paul Rem 03-06-2014.
[5] Centraal Laboratorium, 'Meubel "Schilpad" [sec] ref. werknr. 93.190, briefnr 778', Amsterdam 02-11-1993.
[6] Williams 2002: 36.
[7] For instance Gintl 1874; Lehner 1892.
[8] Williamson 2002: 36.
[9] Lehner 1883.
[10] Lehner 1883: 86.
[11] Lehner 1883: 22.
[12] Idem. When tortoiseshell is glued to a substrate, the weight is of course not important, only when it is used in objects like mirrors, combs etc.
[13] Lehner 1883: 62.
[14] Brydson, 857.
[15] Conversation with curator Paul Rem 03-06-2014.
[16] Lang 1996, Kaner 1999, Kaner 2010.
[17] Kaner 2000.

[18] Rivers & Umney 2012, Stoner & Rushield 2012.
[19] Williamson 2002.
[20] It was decided not to use the conservation grade epoxies Hxtal nyl-1 or Finebond, because the surface was large, making their use very expensive. Also, the properties that make them useful in conservation, the specific refractive index and the supposed non-yellowing, were not relevant in this case.
[21] Unger et. al 2001: 496.

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Photography credits

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