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Black Lacquered *Papier-mâché* and Turned Wooden Furniture: Unravelling the Art History, Technology and Chemistry of the 19th-Century Japanning Industry

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ABSTRACT

A set of 19th-century furniture in black lacquer, on *papier-mâché* or on turned wood, has been subjected to an in-depth observational, historical and chemical study. The results show four different technological approaches: two for the *papier-mâché* objects and two for the wooden chairs. The cyclic labour-intensive lacquering procedure of repeated stoving and polishing lacquer on *papier-mâché* with mother-of-pearl inclusions is reflected in the cross-sections. *Pinaceae* resin and heated oil are frequently found, conform with surviving recipes. A variant of 'the old form of varnish', as historically described, was likely used. In the two pairs of wooden chairs, the lacquer layers are thinner than on the *papier-mâché* items. They contain copal and show different stratigraphies. These observations can be the starting point to relate technological and chemical variations to different origins. New art historical findings on lacquer production and trade in England, France and Belgium, and the study of contemporary recipes, frame the analytical results in a historical context.

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KEYWORDS
Japanning; THM-GC/MS; *papier-mâché*; mother-of-pearl; 19th-century

Introduction

The *European Lacquer in Context* project (ELinC) studies the history of European lacquer, specifically looking at its art historical meaning, the materials used and the way they were applied, as well as the challenge of analysing their chemical composition. The project focuses on lacquer production in the region of Belgium and lacquered objects of western European origin, now in the Museum for Art and History (KMKG/MRAH) in Brussels, Belgium. During the project, a group of 19th-century black lacquer objects, seemingly belonging to the same tradition but stylistically heterogeneous, raised questions about conservation materials and on the production method. The group includes four black lacquered pieces of furniture, two hand screens, one glove-box, all in *papier-mâché* with integrated mother-of-pearl decoration, and two pairs of black lacquered wooden chairs (Figure 1, Table 1) (Derveaux-Van Ussel 1979, cat. 62, 68). The *papier-mâché* items with mother-of-pearl decoration form a homogeneous group while the wooden chairs are stylistically distinct. The objects were acquired by the museum in 1977 from at least two private collectors to decorate the hotel Bellevue in Brussels, which was attached to the Royal Museum for Art and History from 1977 until 1998. Historical data to determine their country of origin and place of original acquisition are absent. As a matter of fact, many of these fashion items were

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Figure 1. Overview of studied objects. Tilt top table M69, hand screen M72b, chairs M70, M73, M74, M75 (one chair of two) and M76 (one chair of two), and glove-box Bi146. © KMKG-MRAH.

made in early industrialised England, being important testimonies of the rapidly changing taste and industrial innovation of the period. They were largely exported to the continent but also copied locally, more specifically in France. While the English production is being documented (Kopplin 2010, 71–74; Jones 2012), less is known about production on the continent and the economic relationships between all the stakeholders. To our knowledge, neither a stratigraphic study nor chemical analyses have ever been published on this type of black lacquered objects.

Methods

To explore the technological build-up of these items, they were closely examined and analysed. Chemically speaking, European lacquers are complex, layered combinations of various natural materials, including resins, oils and solvents. With their diverse constitution and the impact of aging on their molecular composition, identification of the ingredients used can be challenging. Microsamples were taken from most objects, and cross-sections were made (embedded in polymethylmethacrylate; CS). Unfortunately, the

Table 1. Overview of the group of 19th-century black lacquer objects in KMKG/MRAH.

Description	Materials	Inventory	Period, region	Analysis methods	Summary of results
Tilt top table	*papier-mâché* (and wood), mother-of-pearl decoration	M69	Around 1850, England	CS, SEM-EDX, THM-GC/MS, MRS	Type 1. Black size, 3–5 lacquer layers (oil, *Pinaceae*), with lead (and sometimes black) accumulations near lacquer interfaces. 2 transparent layers on decoration (oil, shellac). Decoration in hand cut mother-of-pearl, paint (including lead white, emerald green) and gilding (gold leaf). Total thickness c. 185–350 µm
Glove box	*papier-mâché* (and wood), mother-of-pearl decoration	Bi146	Around 1850, England	CS, SEM-EDX	Type 1(?) Black size (?) and several lacquer layers, with lead accumulations near interfaces. Decoration in hand cut mother-of-pearl, paint and gilding. Total thickness unknown.
Hand screens	*papier-mâché* (and wood), mother-of-pearl decoration	M72a, b	Around 1850, England		Decoration in hand cut mother-of-pearl, paint and (limited) gilding.
Arm chair	*papier-mâché* (and wood), mother-of-pearl decoration	M70	Around 1850, England	CS, SEM-EDX, THM-GC/MS, MRS	Type 2. Light and dark sizing, 5 lacquer layers with black interfaces (oil, *Pinaceae*), transparent varnish on decorations (oil, copal). Decoration in mechanically cut mother-of-pearl, gilding and (limited) paint. Total thickness c. 230 µm.
Chair	*papier-mâché* (and wood), mother-of-pearl decoration	M73	Around 1850, England	CS, SEM-EDX, THM-GC/MS, MRS	Type 2. No sizing (?), 5 (?) lacquer layers with black interfaces (oil, *Pinaceae*), transparent varnish on decorations (oil, shellac). Decoration in mechanically cut mother-of-pearl of different shades and gilding. Total thickness c. 115 µm.
Chair	*papier-mâché* (and wood), mother-of-pearl decoration	M74	Around 1850, England	CS, SEM-EDX, THM-GC/MS, MRS	Type 2. Coarser (lacquer?) sizing, 6–7 lacquer layers (oil, *Pinaceae*) usually with black interface in between, covered with dark pigmented layer, and transparent layer (shellac, copal). Decoration in mechanically cut mother-of-pearl of different shades and gilding. Total thickness of c. 175 µm.
Chair	Wood, mother-of-pearl decoration	M72a, b	1850–1900, France?	CS, SEM-EDX, THM-GC/MS, MRS	Type 3. Pb-Zn ground layer, black layer, 1 lacquer layer, 1 transparent top layer. Contains *Pinaceae*, oil, copal. Decoration in (limited) hand cut mother-of-pearl, paint and gilding. Total thickness c. 40–100 µm.
Chair	Wood	M72a, b	1850–1900, France?	CS, SEM-EDX, THM-GC/MS, MRS	Type 4. black layer, 1 lacquer layer (?), 1 or 2 transparent top layers. Contains *Pinaceae*, oil, copal. *Chinoiserie* decoration in embossed gilding (gold leaf). Total thickness c. 55 µm.

delicate condition of the two hand screens did not allow enough sampling or other in-depth study, they will not be discussed further. All cross-sections were studied and photographed with a microscope (Zeiss Axio M.1 Imager) under visible, polarised and ultraviolet (UV) light. Then, cross-sections were analysed with scanning electron microscopy in combination with energy dispersive X-ray detection (SEM-EDX) for their inorganic composition (Zeiss EVO 15LS backscattered electron four quadrant-BSE detector and a X-MAX^{N}80 silicon drift EDX detector, with measurements under variable vacuum and a voltage of 15 kV). A few locations were additionally characterised by micro-Raman spectroscopy (MRS; Renishaw inVia, 785 nm, 1200 l mm^{-1} grating, Peltier cooled to 203 K, NIR enhanced deep depletion CCD detector (576 × 384 pixels), with laser power reduced to avoid damage).

If possible, samples were taken from the individual lacquer layers to determine organic composition, with thermally assisted hydrolysis and methylation gas chromatography/mass spectrometry (THM-GC/MS). In the pyrolysis unit (Frontier Lab EGA-PY3030D) the sample is broken down at 480°C. After chemical derivatization using tetramethylammonium hydroxide (2.5% TMAH in methanol - 4 µl in a stainless-steel analysis Eco-cup), a helium carrier gas (0.9 mL/min) brings these compounds into the GC (Thermo TraceGC, Supelco SLB-5 ms column, 20 m x 0.18 mm x 0.18 µm). The following oven temperature programme was used: 1 min at 35°C, 10°C min^{-1} to 240°C, 6°C min^{-1} to 315°C, 5 min at 315°C. The separated compounds are detected by an ion trap mass spectrometer (Thermo PolarisQ).

The pyrogram was manually and semi-automatically scanned for marker compounds from natural and synthetic resins, oils, waxes or proteins. The semi-automatic searching of the pyrogram was carried out using the Automated Mass Spectral Deconvolution and Identification System (AMDIS), with a researcher-developed mass spectral library based on artificially aged resins, in addition to an inter-institutional mass spectral library with interpretation system (ESCAPE, see van Keulen and Schilling (2019)) and published reference data (Anderson and Winans 1991; Anderson 1995; van den Berg 2012; van Keulen 2015; Schilling et al. 2016).

Results

With these analyses, four different technological approaches could be discerned: two for the *papier-mâché* objects and two for the wooden chairs. The different approaches are shown in the sections below.

Black lacquered tilt top table with integrated mother-of-pearl decoration (M69) – English

Figure 2 shows the stratigraphical build-up for the green decoration on the base. A rather thick black pigmented layer is applied directly on the *papier-mâché* support (L1 – 30–50 µm, possibly absent in the middle part of the table). The polyaromatic hydrocarbons found in this layer (anthracene, pyrene in this case) seem to indicate a soot-containing black pigment such as lamp black. Chromatography (Figure 3) shows drying oil, probably linseed oil (palmitic/stearic acid, FA-C16:0/FA-C18:0, P/S = 1.1. azelaic/palmitic acid FA-2C9/ FA-C16:0, Az/*P* = 1.6), is an important component and likely the main ingredient. The low amount of the di-acids azelaic to suberic acid (FA-2C9/FA-2C8, Az/Sub = 1.6) suggests that the oil (or maybe the object) has been thoroughly heated (van den Berg, van den Berg, and Boon 1999; van den Berg, Ossebaar, and van Keulen 2002; Mills and White 1994, 32–33).

The detected tricyclic diterpenoids are identified as compounds formed upon oxidation of abietic acids: dehydroabietic acid (DHA), 7-oxo-dehydroabietic acid, 15-hydroxy-7-oxodehydroabietic acid, and 7-oxo-tetradehydroabietic acid. These compounds are markers for aged diterpenic *Pinaceae* resins, such as colophony (Mills and White 1994, 100–102; Pastorova et al. 1997; van den Berg 2012). The detection of 2, 4, 5, 7-tetramethylphenanthrene could suggest that this resin was heated or that pine pitch may have been used (Simoneit et al. 2000).

This layer is followed by three to five dark, translucent lacquer layers (L2). At the interface of some layers, a thin layer of black pigment, presumably lamp black, was observed. Most specific for this type, however, is that SEM-EDX mapping demonstrates an accumulation of lead (Pb) near the interfaces between the lacquer layers. This presumably indicates the use of a lead salt as a drier, well dispersed in the liquid lacquer. Most likely, the mobile lead ions partly migrated towards the surface of the coating during each stoving cycle for the object. This resulted in an enrichment of lead near the surface after every new cycle of varnish application and stoving. The organic composition of this lacquer is similar to the first black layer, with heated drying oil (Az/Sub = 1.3) as the most important constituent. Again, (heated) *Pinaceae* resin is found, but the relative signal for polyaromatic hydrocarbons is weaker, indicating a smaller content of soot-containing black pigment, yet suggested by the lighter and more translucent aspect in the cross-section.

For the decoration, emerald green and lead white oil paint decoration were locally applied on the base (L3), as was gilding, followed by two UV-fluorescent varnish layers (L4–L5). Although sampled and analysed together, it is likely that the lower consists of linseed oil, while the upper is likely to be a shellac-based varnish, with its typical pinkish fluorescence. These top varnishes are exclusively applied on top of the painted or gild-decorated parts.

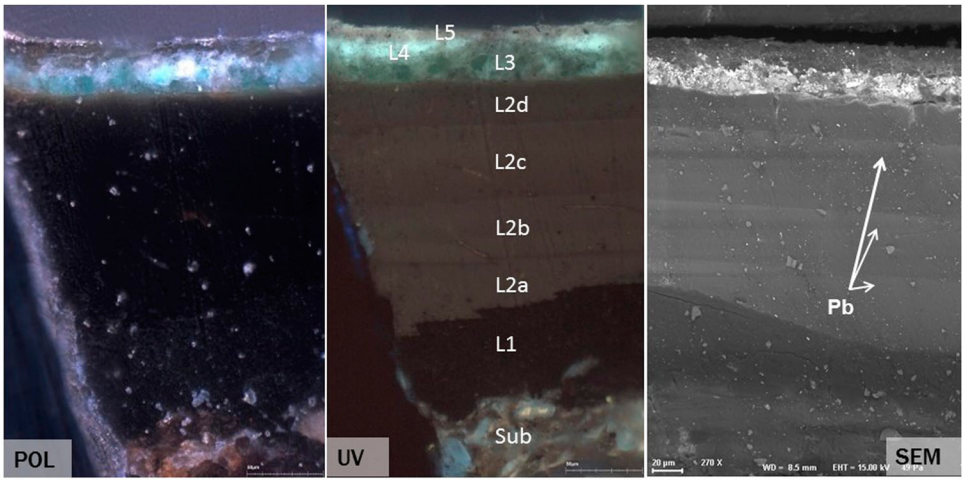

Figure 2. Cross-section of a sample taken from the foot of the tilt-top table M69, observed with an optical microscope 500x, using polarized white light (left) and UV light (middle). Backscattered electron image with SEM (right). © KIK-IRPA.

The one cross-section taken from the glove-box (Bi146) was less clear, and further sampling for organic analysis was impossible. However, lead accumulations at the lacquer interfaces, and a black pigmented base layer, were both observed.

Three chairs in papier-mâché *(M70, M73, M74) – English?*

The three chairs in *papier-mâché* share a similar stratigraphical build-up, reflecting the known technique of repeated stoving of the object (see further). A simple black first layer with a high pigment volume concentration is absent and is replaced in a way that seems less consistent within this group. In one chair (M74), the first lacquer layer is not heavily pigmented, rather coarse in structure and slightly darker in colour compared to the subsequent lacquer layers. Figure 4 shows the stratigraphical build-up in another chair (M70). It seems two preparatory layers exist (L1 + L2). The first seems translucent; only the second one is charged with black pigment. In the third chair (M73), a distinct first preparatory layer under the standard lacquer layers was not found. However, since only one cross-section was taken for each object and locations were variable, the differences observed in preparatory layers of the three chairs may not be as significant.

Five to six dark, translucent lacquer layers were applied to all three chairs. The liquid lacquer did not contain a lead salt, and the interfaces between the layers can only be rendered apparent with UV illumination, not with SEM-EDX mapping. A very fine-grained organic black pigment, such as lamp black, was applied during the in-between polishing. The organic composition of the lacquer layers resembles that of the tilt-top table. Drying oil has been heated

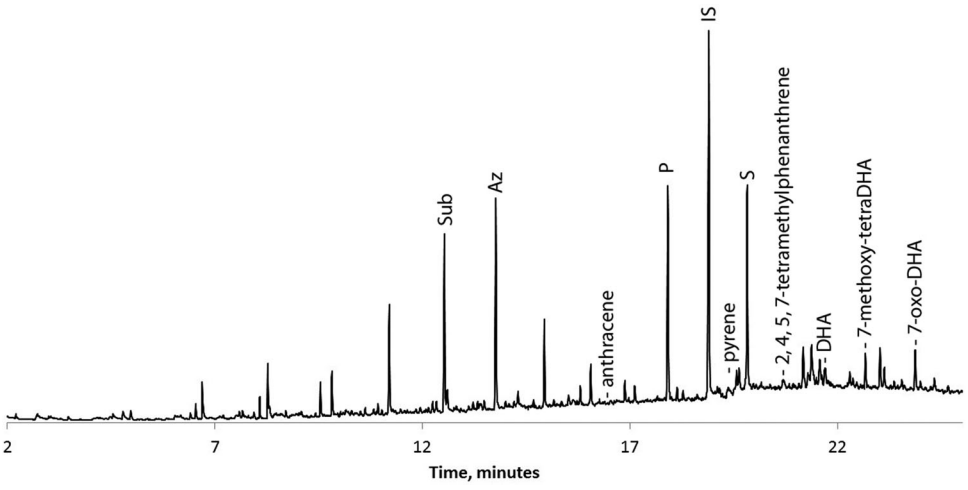

Figure 3. Chromatogram of the black layer (L1) in the foot of tilt-top table M69. Main peaks are fatty acids (including suberic acid Sub, azelaic acid Az, palmitic acid P, stearic acid S and internal standard IS), indicative for heated drying oil. Smaller peaks for anthracene and pyrene indicate soot. Peaks at 21–25 min include markers for *Pinaceae* resins (DHA: dehydroabietic acid), 2, 4, 5, 7-tetramethylphenanthrene could indicate a heat treatment. © KIK-IRPA.

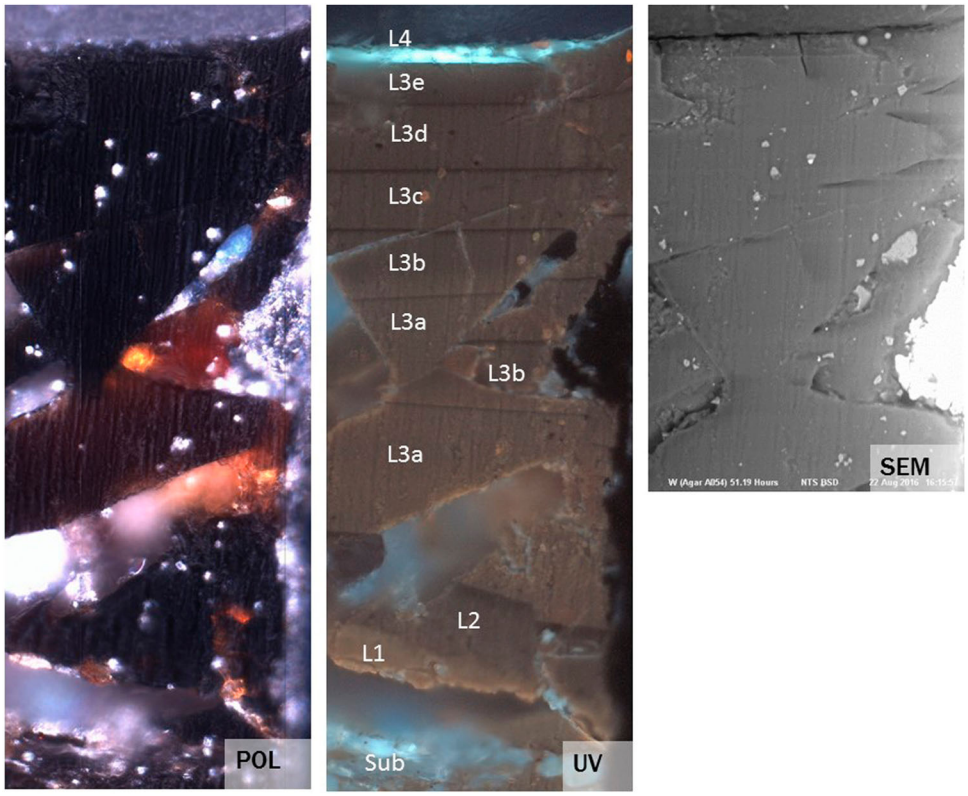

Figure 4. Cross-section of a sample taken from the back-rest of *papier-mâché* chair M70, observed with an optical microscope, using polarized white light (left) and UV light (middle). Backscattered electron image with SEM (right). © KIK-IRPA.

thoroughly (Az/*P* = 0.87–1.08. P/S = 0.94–1.21. Az/Sub = 1.11–1.36). Oxidation products of *Pinaceae* resin were found on all three objects. There is no indication that this ingredient was heated. The anthracene present in the lacquer of all objects, suggests that soot-containing black pigment, such as lamp black or tar, was added in between the lacquer layers, and might have been added in the liquid lacquer as well. In both M70 and M74, other aromatic components were detected, including catechols, hydrocarbons, alkyl benzenes, carboxylated benzenes and naphthalene, the reason for which was not elucidated. While these structures are present in *Anacardiaceae* resins used in Asian lacquer, the compounds found in this case are in general short-chained and do not follow the expected distribution for oriental lacquer. Although it is tempting to suggest it, the evidence is too weak to consider that *Anacardiaceae* resin was added and degraded during heating. In both, proteins were detected as well.

As in the tilt-top table, a transparent protective layer covers only the decorative parts. Interestingly, these top varnishes are not identical in the three chairs: mixtures of linseed oil-copal-*Pinaceae* resin (M70); linseed oil-shellac (M73); and shellac-(Manila) copal (M74) were found. While grouped in this article for stratigraphical and compositional similarities, differences between the three chairs seem to suggest slightly different practices.

Two pairs of turned wooden chairs in black lacquer (M75 and M76) – French?

The model of the two pairs of chairs (M75 and M76) would appear to be rather French. This type was introduced in the years 1830s and was produced in large quantities in the second part of the 19th-century in France. Similarly constructed but stylistically different chairs, were made also in England (Payne 2013, 172, upper right figure). Although made entirely of wood, their decoration and general appearance resemble the objects in *papier-mâché* studied here. Analysis can now show, however, another technological approach is applied. Clearly, the complex stratigraphy caused by the multiple stoving is absent; the total stratigraphy is thinner in both pairs: in M75a the total thickness measures about 20–40 µm, in M76a about 40 µm including gold decoration.

Pair of turned wooden chairs in black lacquer with mother-of-pearl floral decoration (M75) – French?

Figure 5 shows the stratigraphical build-up of a black sample in the back-rest of M75a. Layers are generally much thinner, and separate sampling was not possible for all layers. Some ingredients can only tentatively be attributed to a certain layer. First, a thin preparatory layer with lead and zinc, probably a mixture of lead

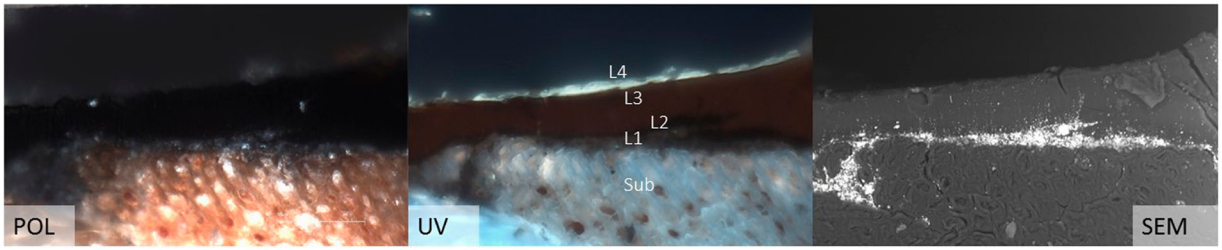

Figure 5. Cross-section of a sample taken behind the seating of turned wooden lacquer chair M75a, observed with an optical microscope, using polarized white light (left) and UV light (middle). Backscattered electron image with SEM (right) © KIK-IRPA.

white, lamp black and zinc white, was applied (L1–10 µm). It homogenises the surface and ground colour for the whole surface and lowers the porosity of the wood. Next, a thin black layer was applied (L2–3 µm). Polyaromatic compounds found in a sample of the lower layers (L1–L3) suggest a soot-containing pigment such as lamp black may have been used in this layer. The black layer is covered with only one layer of rather dark, translucent varnish (L3–30 µm). This dark layer shows markers indicative for oxidised *Pinaceae* resin. The additional presence of 2, 4, 5, 7-tetramethyl][phenanthrene might suggest it has been heated, or pine pitch was used. Several pyrolysates of polycommunic acid (Anderson and Winans 1991; van den Berg, Ossebaar, and van Keulen 2002; Augerson 2011; van Keulen 2015), and some additional markers (unidentified markers present in in-house compiled library based on artificially aged resins at RI1839, 1862, 1612) previously found in polycommunic acid based copals (such as Kauri and Manila copal) indicate the presence of copal. Heated linseed oil seems to be present in this layer. Soot was detected in this same sample, but this could indicate a contamination of the black underlying layer during sampling. Some aromatic compounds, including 1-propenyl-benzene and carboxylated benzenes, may be related to the black pigment or heating during varnish preparation. Finally, a transparent protection layer covers the whole surface (L4–3 µm). It is unclear whether it was part of the original lacquer. This layer contains heated linseed oil (Az/P = 1.62. P/S = 1.60. Az/Sub = 1.59) and copal, probably Manila copal or Kauri copal. The presence of *Pinaceae* resin cannot be excluded.

Pair of turned wooden chairs with chinoiserie *decoration (M76) – French?*

For these chairs, a thin carbon rich black layer covers the wooden substrate. Adhesion layers for the gold leaf contain lead (lead white), calcium (possibly chalk), and barium sulphate. A final transparent layer covers the whole surface (Figure 6).

Lacquer layers could not be sampled and analysed individually, and only one sample for THM-GC/MS analysis was taken, from the black lacquer without gold decoration. Oil, *Pinaceae* resin and copal were found. Fatty acid ratios (Az/*P* = 1.75. P/S = 1.27. Az/Sub = 2.66) suggest a mixture of heated and unheated linseed oil. Oxidation products of *Pinaceae* resin were found. Pyrolysates of polyozic acid indicate the presence of American or African copal (Anderson 1995; van den Berg, Ossebaar, and van Keulen 2002; Augerson 2011; van Keulen 2015).

The methodology of lacquering in 19th-century Europe: the English tradition

The English *papier-mâché* objects studied here date from the middle of the 19th-century when many japanners bought their varnish from specialist suppliers and its components were fairly standardised. Nevertheless, to judge from contemporary ledgers, some japanners, when ordering their varnish, would request minor adjustments to suit the purpose for which it was required and no doubt many others adapted the varnish upon purchase. in these early industrial times, precise recipes are difficult to define, but certain ingredients and methods can be expected. Before the discussion of results of chemical analysis, a brief general description of what is known from written sources of the early industrial varnishing process of this type of black furniture in the middle of the 19th-century in England, may be useful.

The objects are products of an industry which owed its inspiration to eastern lacquer. When the Dutch East India Company (VOC) first imported oriental lacquer into Europe in the 16th century, those who could afford its high price were eager to acquire pieces with which to adorn their homes. This diverted trade away from European cabinet makers who, in an attempt to protect their businesses, demanded an increase of import duties on lacquerware by the English Parliament (Bowett 2001, in a document named *The Case of the Japaners* [*sic*] *of England* 1692, (Anon. 2016)). In order to compete, they set about imitating the exotic imports. Their earliest varnish, based on shellac, came to the attention of John Hanbury (1664–1734), proprietor of the Pontypool tin-plate works in Wales, who sought a durable finish for his domestic tin-plate articles. On finding that it did not adhere sufficiently to metal, one of his workmen, Edward Allgood (1681–1763), overcame the problem

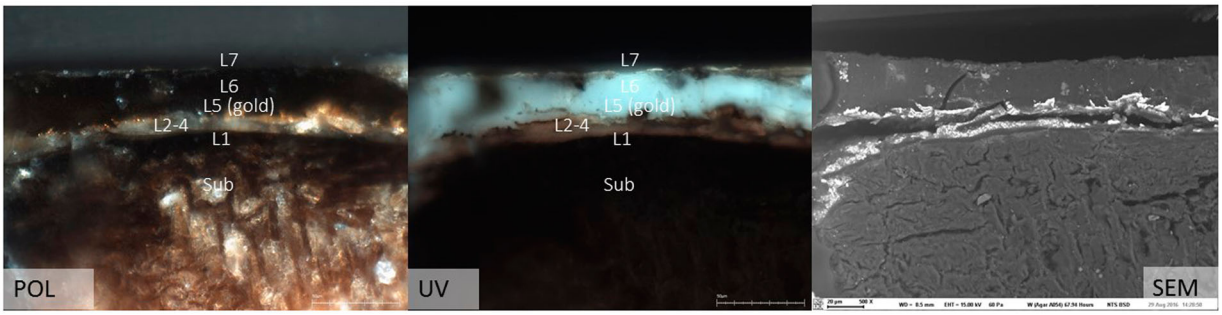

Figure 6. Cross-section of a sample taken from the golden decoration on the left front leg of turned wooden lacquer chair M76a, observed with an optical microscope, using polarized white light (left) and UV light (middle). Backscattered electron image with SEM (right). © KIK-IRPA.

by the addition of asphaltum and linseed oil but then found the varnish needed to be slowly baked in an oven or stove in order to thoroughly harden it (John and Simcox 1966; Nichols 1981). It was this need for stoving which distinguishes the *industrial* products of 18th- and 19th-century Europe from earlier western imitations.

The industry soon spread to the English metal-working towns of Birmingham, Wolverhampton and Bilston and thence across Europe where, by the 1740s, the japanning of *papier-mâché* had begun in France. By the late 1750s, *papier-mâché* manufacture had started in Birmingham where it would become one of the town's staple industries for well over one hundred years. This new and plastic material had the advantage over wood of requiring neither filling nor smoothing before the japanning process.

A black ground layer, such as that seen on most chairs and the table, could be achieved by priming the surface with a mixture of *sizing varnish* and lamp black. After this had been stoved for 30–40 min, it was thinly coated with a varnish made by mixing together boiled rosin, finely powdered amber, spirit of turpentine, sarcocolla (a Persian gum) and ivory or lamp black. It was then stoved until tacky and left to cool and soak into the paper. Up to 5–6 coats of varnish were required, and up to twelve coats for the finest goods. The first layer of varnish was stoved at 120–140°C for six hours, or overnight, and the temperature raised for each subsequent stoving as each successive coat of varnish was applied more thickly (Jones 2012, 42). This was essentially '*the old form of varnish*' that Robert Hunt described in 1851 although as he went on to observe, 'good asphaltum or the true resin of petroleum dissolved in strong turpentine would appear to answer very much better' (Hunt 1851). Certainly, at a meeting at Mander's varnish works in Wolverhampton in 1865, it was reported that Birmingham varnish makers were producing 'common varnish' with petroleum spirit in place of more costly oil of turpentine (Mander 1955, 147; Jones 2012, 38–87).

Essentially, there were two methods of making *papier-mâché*: the so-called *common method* which used pulped paper, and the *best method* which was the one used for the objects under discussion; it was made by laminating sheets of specially-produced making-paper to form 'pasteboard' which after several stovings, and oiling, could be sawn and planed like wood (Figure 7) (Jones 2012, 22–37). The steam-moulded double-curve of the chair-back M70 gave the paper great strength. However, strong though it was, pasteboard would not support the weight of a person and so the seats and legs of chairs were made of wood. To prevent those parts from cracking or warping when stoved, a hole was drilled throughout the length of the wooden parts, and they were steeped in oil and slowly baked prior to japanning. Notwithstanding, the join between pasteboard and wood was one of weakness and it is not uncommon to find that chairs have been repaired at this point, such as chair M74. Table legs such as for table M69 were generally made, like most *papier-mâché* hollow-ware, by layering small sheets of making paper over a hardwood mould until half the required thickness was reached. It was then cut into two, either horizontally or vertically, taken off the mould and glued together again before further layers of paper were added. For extra stability, an iron tube was inserted in the hollow table-leg, and the base of the table was weighted.

It is popularly believed that pearl-decorated *papier-mâché* dates from 1825 when the Birmingham firm of Jennens & Bettridge took out a patent (#5137) in respect of cutting pearl shell. But the patent was for improved cutting methods; Henry Clay (1737–1812), the most celebrated of early Birmingham japanners, had used tiny pearl scraps in the 1770s for the decoration of furniture and small articles like tea caddies. Jennens & Bettridge's patent described four ways of cutting ground-pearl more quickly than hitherto. These involved 'stopping-out' the intended design with asphaltum and oil or spirit of turpentine and removing the unprotected parts with nitric acid or, conversely, entirely covering

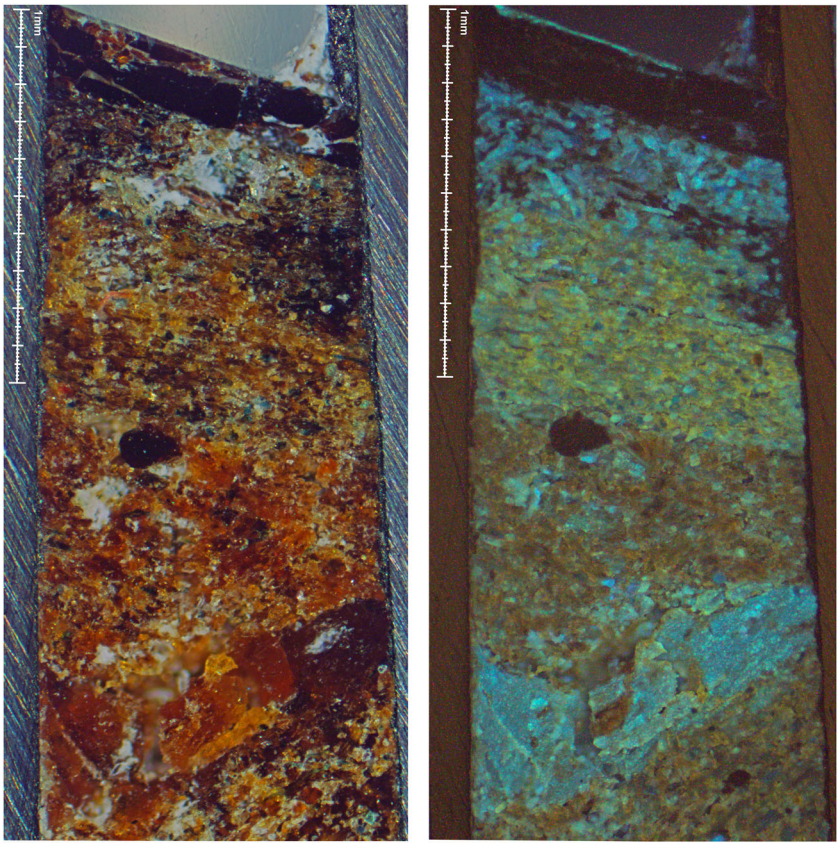

Figure 7. Cross-section of a sample taken at the side of chair M73, observed with an optical microscope 50x, using polarized white light (left) and UV light (right). Laminated sheets of specially-produced paper can be discerned in UV light. © KIK-IRPA

the pearl with a stopping-out fluid, scratching the design into the dried surface with a needle and brushing the whole with an acid which, attacking only the pearl exposed by the outline, produced the required shape. The patent also specified how to create relief-decorated pearl – an effect which appears to have been rarely employed by japanners. More significant was a method of cementing together six to twelve layers of finely ground pearl, drawing the design on the top layer and placing the stack in a vice; the design could then be cut with files, saws and drills prior to separating the layers with solvent. However, in spite of these improvements, a pearl-cutter was observed using scissors at McCallum & Hodson's Birmingham factory, in 1850, to cut the various shapes by eye.

The pearl was ground to between 0.3–0.6 mm thickness. A detail of the decoration on one of the gondola-shaped chairs, M70, shows how the shell was broken into pieces, to accommodate the curved surface of its back (Figure 8). Tiny off-cuts were saved to create so-called 'scrap pearl' borders (Figure 9).

Contrary to appearances, pearl was not inlaid in the generally understood sense but was attached to the surface of the object after the first varnish layer had been applied (Jones 2012, 43–87). When firmly attached, the entire surface, including the pearl, was given a further coat of varnish and returned to the stove. Once stoved and thoroughly cooled, the surface was rubbed down until the pearl was exposed, and then the article was given a further layer of varnish and returned to the stove; this process was repeated until the level of the varnish was equal to that of the pearl. On many examples found today, it will be seen that oils in the varnish have dried causing its level to shrink below that of the pearl. Frequently, pearl surfaces were thinly painted with colourful glazes to make them blend more fully with the overall design but, today, this colour-wash is often found in very chipped condition.

Figure 8. A detail of the decoration on one of the gondola-shaped chairs, M70, shows how the (mechanically cut) shell was broken into pieces, to accommodate the curved surface of its back. © KMKG-MRAH

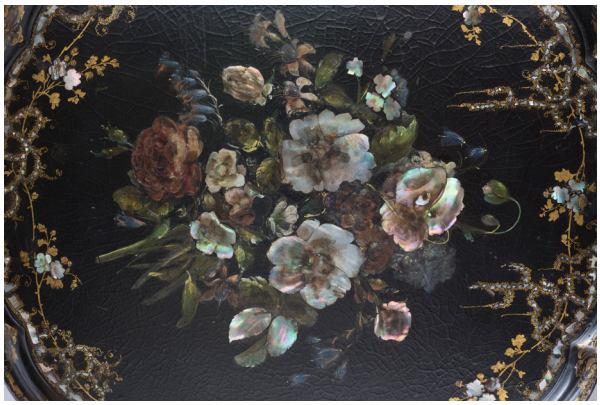

Figure 9. Table top of M69. Tiny off-cuts were saved to create so-called 'scrap pearl' borders. © KMKG-MRAH.

Once polished, the article was ready to be painted with pigments suspended in mixing varnish – a mixture of co-called 'copal varnish', oil and gum animi[1] and spirits of turpentine – and gilded. Floral motifs such as petals, leaves and veins could cover the pearl to result in a decoration of refined depth and transparency. Finally, the decorated parts of *papier-mâché* were protected by a local thin layer of 'copal varnish' which is readily discernible, in certain lights, in the table and three chairs under discussion. Determination of the composition of this transparent varnish was one of the aims of this study.

Discussion

The production process of lacquered *papier-mâché* objects as described in written sources reflects remarkably well in the cross-sections and chemical analyses. The first black layer was sometimes absent and small differences existed, but soot-containing black with sizing varnish was generally used. Then three to seven lacquer layers were applied. These layers contain, as in the previously discussed 'old form of varnish', *Pinaceae* resin which in some cases seems to be heated -as in boiled rosin- and lamp black. Unfortunately, smaller quantities of amber can, especially in presence of oil and *Pinaceae*, go undetected, as can gums, for which THM-GC/MS is not very sensitive. Asphaltum was not found during analysis. Neither was petroleum spirit, but highly volatile, this ingredient is unlikely to survive aging even if present in quantities during production.

Remarkably, linseed oil, not present in Hunt's recipe, was found in all the *papier-mâché* objects investigated; fatty acid analysis clearly shows the oil has been heated. Boiled linseed oil could have been used, to minimise drying time. However, repeated stoving of the object may also explain the shifted fatty acid ratios. It is likely that the repeated stoving process in itself affects the lacquer to such an extent that analysis of the lacquer will suggest it was heated. However, historical sources suggest boiled linseed oil was chosen to speed up the drying process. The mention of boiled linseed oil appears frequently in early accounts, and especially those in relation to the japanning of metal. For example, Robert Dossie in *The Handmaid to the Arts* of 1764 (Dossie 1764, 1:493), described how tortoiseshell effects involved boiling linseed oil and umber together – the method employed at the Pontypool Japan Works in Wales. Linseed oil almost certainly continued to be used in the making of japan varnish. A notebook of varnish recipes compiled by a Birmingham varnish-maker in 1830 includes linseed oil among the ingredients of Pontypool Varnish or Tar Varnish (Postans 1830). Andrew Ure reports the use of boiled linseed oil in black lacquer in 1839 (Ure 1839, 1268), and this is repeated in subsequent editions until 1878 (Hunt 1878, 7). As late as 1874, the varnish-making firm of Mander Brothers in Wolverhampton continued to list linseed oil as a component of japan varnish, in spite of their earlier comments on common varnish in 1865. Although it is not generally encountered in surviving English recipes for this type of furniture, the analysis of M69 and Bi346 shows that some manufacturers chose to add a lead salt to the oily lacquer matrix. A lead salt is a traditional drying agent to speed up the polymerisation of oil, here added in surplus of the heat treatment of both oil and object (Mills and White 1994, 38–41; Hurst 1892, 420).

The cyclic stoving production process can be easily seen on cross-sections as repeated layers of the same lacquer. Even in-between polishing is visible in the presence of (supposed) lamp black in some cases. Especially the appearance of the interfaces between the lacquer layers is different within objects, and they seem to align with differences in the decoration of the objects. Although they did not enter the museum collection in these groups, based on both visual and chemical arguments, the investigated *papier-mâché* objects fall into two separate categories: the tilt top table M69 and the glove box Bi346 in one group and the three chairs in the other (M70; M73; M74). The mother-of-pearl used in the tilt top table and the glove box, in both of which lead was present in the lacquer matrix and accumulated near the layer interfaces, seem to be hand cut – angular and irregular in shape (Figure 9). The floral *motifs* are rich in colour, while gold is less abundant. On the other hand, in the three chairs, where the *Pinaceae* component does not seem to be (as) heated, lead is absent and interfaces are delimited by a thin layer of (supposed) lamp black, the mother-of-pearl decoration shows a method of systematic cutting: multiple identical flowers, leaves and circles occur frequently, cut in more round and fluent forms (Figure 8). The negative left-overs of these cut-outs are also frequently used in smaller decoration. Snail shell and

aurora mother-of-pearl is used and decoration in gold predominates.

For all the *papier-mâché* pieces of furniture, a last transparent finishing lacquer layer was applied, only on the painted decoration. This local application of varnish is not a general practice, but other examples exist in museum collections. A locally applied protective layer was found on a *papier-mâché* chair (W.70–1923) and an armchair (W.9–1934), both dated c. 1850, at the Victoria and Albert Museum, London; and on three objects in the Musée au Fil du Papier, Pont-à-Mousson, France (black tray 97.5.57 dated c. 1850, *table à ouvrage* 97.83.05 and hand screen 97.45.08). In the decorated areas, they share a marked greenish fluorescence under UV light with the chairs and table studied here. This technique is historically described as a 'copal varnish', protecting the fragile glazes and gilded decoration and increasing brilliance (Jones 2012, 83). It is remarkable that copal is not always present, and quite a compositional variety was found in the analysis of only a few objects, all different combinations of drying oil, shellac, copal and *Pinaceae* resin. This surprising diversity can testify for a variety of craftsmen specialised in the final varnishing in so-called varnishing shops (Jones 2012, 83), in contrast with others responsible for the decoration phase, or for the black lacquer and the repeated stoving of the pieces in so-called blacking shops (Jones 2012, 40–41).

The lacquer on the slightly later, probably French, wooden chairs (M75, M76) shows a different technological approach. While the multi-layered lacquer on *papier-mâché* measured about 120–250 µm in this study, the complete covering on the wooden objects measures only about 40 µm. A black pigmented layer is covered with one or two thin lacquer layers of copal varnish. For the preparation of this varnish, linseed oil would have been heated to dangerously high temperatures and mixed with copal and (probably) *Pinaceae* resin. This production process obstructs further identification of the ingredients.

French or English? Geopolitical influence, trade, protection and imitation

These black lacquered items illustrate the history of the European lacquer industry and trade in the international contemporary context. This type of lacquer was made in England, France, Germany, the Netherlands and elsewhere in Europe, as well as in America and Russia. Many of the objects are decorated with the same type of floral arrangement which could have been influenced by the Nagasaki style in Japan (Impey and Jörg 2005, 209–227; Papist-Matsuo 2016, 116–121). Some decorative details recall the Japanese Namban lacquers of the 17th-century (Kopplin 2010, 84). In the absence of a manufacturer's mark or materials analysis of the varnish found on contemporary examples from each country, it is often difficult to distinguish the products of one country from another, and attributions are largely based on stylistic grounds only. Several museums including Au Fil du Papier in Pont-à-Mousson and the Musée des arts décoratifs in Paris have large collections of mid-19th-century japanned objects of different origins, decorated with mother-of-pearl, gilding and painting, the location of fabrication of which is often unknown (Jones 2012, 278–279; Anon. 2008, 64–66). Although we are convinced of an English origin for part of them, this is also the case for the pieces of the Royal Museums for Art and History.

In contrast with the leading position of France in lacquer production during the 18th-century (Dossie 1764, 1:xvi–xvii), France was forced to follow a more modest industrial policy after the defeat of Napoleon at Waterloo in 1815. In the first decade afterwards, they pursued more protectionist politics. The British Empire took full advantage of this situation and expanded its industrial and political influence throughout Europe (Van Binnebeke 2015). This sudden increase in British power could explain why, in France, craftsmen started to adopt English styles of pearl decoration, possibly by using imported English technology, craftsmen, or readymade cut-outs of mother-of-pearl (Jones 2012, 51). Archives reveal that in France, varnished furniture and fancy goods with mother-of-pearl incrustation were prohibited from importation from at least 1842 (Anon. 1842 page XXXIII, 'Meubles', note 8; Anon. 1843; Anon. 1844; Anon. 1845a) and probably until October 1861 (Anon. 1862 table in front of page 282). More specifically, wooden tea tables, bookcases, *tables à ouvrage* and *ouvrages en bois* (such as game-, tea-, tobacco- and sewing boxes), with inlays in ivory, tortoiseshell or mother-of-pearl, were considered '*tabletterie*' and were thus prohibited (Anon. 1842 '*Ouvrages en bois*', n. 2). Most probably, the regulation applied to both wooden and *papier-mâché* items. Similar objects without incrustation but with 'paintings in gold' or with 'gold mixed with diverse colours' were considered furniture or fine *mercerie* and accepted with a tax of 15% imposed. Earlier already, in 1837, specific prohibitions existed, but not for varnished items with inlays (Anon. 1837, 80, 86, 109 '*Meubles*', '*Ouvrages en bois*', '*Tabletterie*'). It seems that in 1842 new specifications were needed to react to a changing situation, perhaps as a protectionist response to rising English imports. Import of raw shells was taxed depending on their type and provenance, ready-sawn mother-of-pearl even more (Anon. 1842, XXXIV). The restrictions could have supported the development of the imitation of the English products. In turn, 'Laquer or items in Chinese varnish' were taxed at 15% of their value by British customs when exported to Great Britain (Anon. 1844, XCV).

Lacquer imitations in 19th-century France

In the usual absence of manufacturing marks and the lack of documentary evidence it is difficult to know to what extent and from when French craftsmen were imitating English products. Some useful indications can be found in contemporary printed texts. In France, according to the catalogues of the exhibitions of the products of French industry, the production of varnished tinware (*tôle vernie*) never ceased, but lacquered pieces of furniture or fancy goods in wood or in *carton* were present only from 1819 onwards, as we can see from the exhibition stand of William Smith in Paris (Anon. 1819, 318). According to the journal *La Mode, revue des modes,* lacquered furniture or fancy goods imitating Chinese lacquers were fully fashionable in 1829 (Anon. 1829, 79, 294). At the same time, English products started to be appreciated for their handiness and comfort, a criterion to which the new lacquered items were responding. In 1834, the printed sources clearly illustrate the importance of japanned furniture and its growing French production. At the French Industrial exhibition, two stands with lacquered items were represented by men and women with Anglo-Saxon names (Messrs. Terrot and William, and Mmes. Kesler and Barn) all settled in Paris (Anon. 1834, 173,180,217, XIII). The lacquers of the French Drugeau-Maucher imitated either the English type or the Chinese type (Anon. 1834, 173). Pearl decoration were then in vogue in France as in England: a lacquered table decorated with mother-of-pearl 'inlays' and relief was shown, and described as an exact imitation of the Chinese type (Anon. 1834, 217; Anon. 1838, 3:166 nr. 1405). Meanwhile, the Frenchman Hérard-Devilliers was said to have developed a new type of mother-of-pearl inlay for his imitations of Chinese lacquers (Anon. 1838, 3:157–158 nr. 1377). A contemporary encyclopaedia gives additional information on lacquers produced by a M. de Villers in Paris (Malepeyre 1834, vol. 4, cols. 154–155, 'Couleurs et vernis: Laques imitant celles de la Chine'). De Villers was making Chinese and English lacquers on wood, tin and *carton,* in which mother-of-pearl decoration was combined with *gilding* and *colour*. The best objects would be those with only mother-of-pearl decoration, without any gilding or painting. De Villers was making his black backgrounds with copal or *karabé*/amber. The mother-of-pearl was inlaid in the lacquer and not glued on the support with a mordant as is the case for the table and chairs of the KMKG-MRAH. At the national exhibition in Paris of 1839, the Frenchman Osmond won a bronze medal for his furniture imitating Chinese lacquers and then a silver medal in 1844 for a 'rich collection of lacquered furniture that reproduces with success the Chinese or Japanese type' (Anon. 1839, 3:183–184; Anon. 1845b, 3:107–108). This Japanese type corresponds most probably to lacquers in the Nagasaki style with mother-of-pearl incrustations and motifs of blossoming trees, flowers, birds and vine branches. In 1844, Charles Mainfroy, known for making lacquers of all styles, (Ledoux-Lebard 1984, 457), won a bronze medal at the exhibition of 1844 for a laminated *papier-mâché* production using a hydraulic or screw press, enabling him to reproduce all forms with moulds in metal or on wooden mandrels (Anon. 1845b, 3:108–109). His innovation rendered the *papier-mâché* impervious, and therefore suitable for furniture, as well as apartment or carriage panels, as already produced in the English industry.

At the Universal Exhibitions of 1851, 1855 and thereafter, lacquers produced by different countries were exhibited side by side. French lacquers were absent from the first Universal Exhibition of 1851, but well represented as of 1855. The competition of the exhibitions seemed to encourage the French producers to improve their imitation of the English lacquers, considered superior, while the English factories enhanced the artistic quality of their products, being criticised by the French jury in 1851 (Anon. 1855, VII:15, XXIXth Jury, section 'Objets de parure, de fantaisie, etc.'). The report of the French commission states *papier-mâché* to be exclusively English while wood was used in China, Japan, Paris, Amsterdam, Vienna and Brussels, which was in fact not the case (Anon. 1855, VII:15, XXIXth Jury, section '*Objets de parure, de fantaisie, etc.*'). The French manufacturers all presented lacquered wood or *papier-mâché* with mother-of-pearl incrustation (Anon. 1856, 2:479). The lacquers of Mainfroy were said to be of good quality and inexpensive, allowing him to export on a large scale. The English firm of Jennens &Bettridge of Birmingham were honoured at length, for the fabrication of *papier-mâché* by superposition of *making-paper* (Anon. 1856, 479–480), the *best method* as described earlier. It indicates that this method had not yet been extensively adopted in France. However, given that Mainfroy, a Parisian, won a medal in 1844 for his laminated *papier-mâché*, it is clear that the distinction between French and English products cannot be based solely upon whether they were manufactured by the pulped or layered method.

While the worldwide exported products of Jennens & Bettridge were distinguished by the jury in 1855 for 'their perfect smooth surfaces, the exact polish and the beauty of the black backgrounds that can be compared to the most beautiful results obtained in Japan and India', in 1867, the quality of the French lacquers is judged equivalent to the English by an English jury (Jones 2012, 286).

Lacquer trade in Belgium

As a neighbouring, industrially thriving young country, one could wonder about Belgium's position in this

international lacquer industry. Luxury lacquered goods from England and France were of importance for 18th-century Belgian interiors, as illustrated by their presence in the collection of KMKG-MRAH. Little has yet been published on these imports, but archival research did reveal some elements. From 1846 to 1851, the house of Woolbert, a shop of English commodities, 61 rue de la Madeleine in Brussels, was selling among others 'delightful tables in *papier-mâché* with incrustations of mother-of-pearl that imitates beautifully the Chinese lacquer' (*L'Indépendance belge*, Dec. 29, 1846). In 1851, you could find there 'a nice assortment of objects for New Year gifts in English lacquer of China, that had just come from England' (*L'Indépendance belge*, Dec. 29, 1846). In the same year, they claimed to have received 'a large variety of objects of the Exhibition of London, in inlaid Anglo-Japanese lacquer' (*L'Indépendance belge*, Dec. 6 and 21, 1851). The shop closed in 1856 (*L'Indépendance belge*, Apr. 6, 1856).

Woolbert's main competitor of the house in Brussels was Corr Vander Maeren and Company, which had had English warehouse since 1824, at 14 Longue rue de l'Ecuyer, and another shop in Amsterdam. Corr Vander Maeren was selling products of his own large manufacturing concern established in Sheffield (*L'Indépendance belge*, Dec. 28, 1850). He was selling a great choice of English hardware, including tables and fancy goods in 'lacquer of China', 'English lacquer of China' or 'English lacquer of Japan'. He began advertising in 1850, but mostly in 1851, the year of the Great Exhibition in London. After the exhibition, his products also came from Birmingham (*L'Indépendance belge*, Dec. 21, 1851).

From 1852, the Mechi company in London was running advertisements in the Belgian daily press for his shop located at Leadenhall Street in London. Mechi was selling amongst other things 'all the objects in imitation of the lacquer of China.' (*L'Indépendance belge*, Apr. 30, 1852). The firm claimed that their shops were 'visited by all the foreigners visiting London, and are considered as something that must be seen when visiting the great metropolis of the trade and industry'. From 1835 until at least 1851, imported contemporary English japanned ware seriously competed with articles made in Brussels. Japanners in Brussels working on an artisanal scale were eager to reproduce Chinese and Japanese lacquers and to distinguish their products from those made in France and England.[2]

Occasional announcements published in the daily press until 1857, mention 18th-century lacquered commodes or secretaries of presumably French provenance, which were already considered to be costly antiquities, but shops did not explicitly advertise the new, more affordable lacquers produced in France. Establishments such as the shops of M. Guilmard and M. Grousse sold furniture and fancy goods, including lacquered tables, *tables à ouvrages*, tea tables, boxes, writing tables, of unspecified provenience. Perhaps some of those lacquers were produced in Paris.

Conclusion

The 19th-century production of black japanned furniture in western Europe reflects the geopolitical situation of this region. Early industrialisation enhanced innovation, as illustrated in the development of a new technology of stoving during lacquer production and the use of new materials including *papier-mâché*. England radiated its powerful influence over the continent. Suddenly, they found themselves in the prestigious position of French craftsmen attempting to imitate their orientally inspired lacquer. The resulting competitiveness, encouraged by international exhibitions and tempered by import taxes, promoted innovative progress both in England and on the continent.

For the first time, the objects of this fascinating French–English interaction were subjected to a microscopical and chemical study, in order to compare their build-up with published technological procedures. The synergy of art historical research, archival study on technology and recipes, and materials analysis reveals new insights into this type of object. A general production method is seen for all *papier-mâché* objects, with *papier-mâché* applied in sheets, and a layered lacquer reflecting cyclic stoving of the object. Smaller differences amongst them suggest different workshops and decorators at work. As historically described, the probable use of linseed oil, boiled rosin and lamp black was seen in the four pieces in *papier-mâché* of presumably English origin. Lacquer on the slightly later, probably French, wooden chairs is considerably thinner, even when mother-of-pearl was applied. The lacquer contains copal, oil and *Pinaceae* resin. It would be interesting to compare more objects, preferably of known origin, to better understand how technology in both England and France evolved and how exactly they influenced each other on a technological level. Hence, this study could be a starting point to better understand larger groups of 19th-century black lacquered furniture, revealing groups of shared methods, and discerning different regions of production and manufacturers, in England, France and abroad.

Notes

1. The name *gum animi* has been used to denote several different resins, most often copal resins (Webb 2000, 107)
2. Study presented in Ghent for the *Studiedag Historisch Interieur en Design*, 29 April 2017. Publication in preparation.

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