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Creating the illusion of recoloured furniture through light projection

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Miko Vasques Dias (Ed.)

Material imitation and imitation materials in furniture and conservation

Proceedings
Thirteenth International Symposium on Wood and Furniture Conservation
13

Stichting Ebenist
Amsterdam, 18-19 November 2016

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Retouching without touching. Creating the illusion of recoloured furniture through light projection

Federica van Adrichem,* Maarten van Bommel

Abstract

In this article an alternative method for recolouring discoloured furniture is presented. The focus is on two discoloured pieces of furniture: an Amsterdam School buffet and a Rococo marquetry commode that both have lost their bright colours due to fading (figures 1, 2). The buffet was dyed with a mixture of synthetic dyes in a monochrome orange colour. The outside of this buffet has almost completely lost this bright colour, whilst the interior is still bright orange. The Rococo commode was composed of brightly coloured purpleheart and tulipwood veneers, and a dyed marquetry design of flowers in a vase. The commode has faded over time and is now characterised by hues of brown.

It can be stated that both objects in their faded state no longer represent the original idea of their makers. At the same time, it is impossible to have complete certainty about the exact original colour hue of the dyes that were used; the concentrations of colourants that were used have so far been impossible to retrieve, and they have a significant effect on the overall colour. In general, a physical restoration is not considered a good option as it is thought to be too invasive, and reversibility is difficult to achieve. Such a restoration, in particular since the colours are not precisely known, is considered to be unethical.

This study aims to determine whether it is possible to create the illusion of a brightly coloured buffet and commode by projecting coloured light on the object. Standard presentation beamers in combination with projection mapping software were used. Because of its shape and monochrome colour the buffet was an easier case study and therefore a good start of this study, while the multi-coloured, bombé commode was more of a challenge. Good and realistic results were achieved as light imitates the qualities of dyed wood well. This paper describes the different steps to arrive at an accurate 'retouching' of the objects using coloured light. This includes chemical analysis, physical reconstructions based on historical recipes, degradation research, botanical identification of the flowers on the commode, a careful mapping of both objects, and finally the projection. Not all steps have been undertaken for both objects, however, we believe that the research strategies described can form a base for further studies.

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Introduction

Our perception of colour is highly influenced by the light in which we see an object: the combination of the reflection spectrum and the spectrum of the light determines the colour. The aim of this study was to determine whether it is possible to create the illusion of a recoloured object by changing the light, rather than changing the object.

The fading of furniture is a complicated matter; in some cases it is decided to recolour an object. In such a case (reversible) changes are made to the object, in other words, to its reflection spectrum. Actual physical recolouring is generally thought to be too invasive, and as a result of this the furniture is exhibited in its faded stage, not showing the intention of the maker, or is left in the depot as it is, considered to be not fit for display. Contrary to existing methods for recolouring faded furniture, the method proposed in this article is non-invasive, reversible and very flexible. By projecting coloured light onto discoloured objects the illusion

Figure 1 Buffet, P. Kramer, 1933-1936, oak, plywood, softwood, 178 x 123 x 57 cm. Collection RCE, inv. nr. AB-25457-B.

Figure 2 Commode, A. Bongen, 1766, oak, purpleheart, holly, tulipwood. Collection Amsterdam Museum, inv. nr. KA 14352.

of a recoloured object is created. When the light is turned off, the object is shown as it is, in its faded state. Furthermore, if due to new knowledge another colour or hue needs to be projected, one can easily adapt the projected light.

In this article two case studies are presented. First, research was carried out on a buffet that was made between 1933 and 1936 by Piet Kramer (1881-1961) in Amsterdam School style (figure 1). This buffet is part of an ensemble of fifteen pieces of furniture in the collection of the Cultural Heritage Agency of the Netherlands (RCE). A flower marquetry commode, made in 1766 by Andries Bongen, was an even more challenging case (figure 2).
The commode is part of the collection of the Amsterdam Museum. Research on this commode is presented as work in progress, but it shows the potential of the proposed illumination technique. Both objects have in common that they originally were characterised by bright colours, which have faded to different hues of brown. For both pieces of furniture colour is an important element of their design. It can be stated that without their bright colours these pieces of furniture no longer represent the original idea of their makers.
There are multiple ways of using coloured light to create the illusion of a recoloured object. In the field of conservation tests with coloured LED spotlights, lights with colour filters and projection mapping with beamers have been carried out before.[1, 2, 3] In this study it is decided to use projection mapping in combination with beamers. Projection mapping is a projection technology used to turn objects into the display surface for video or image projection. This method is thought to have some clear advantages and has not been tested to recolour faded furniture. Colour can easily be projected and changed when necessary, and multiple colours can be projected simultaneously. Another advantage is that this method can be applied relatively low tech and at low cost.

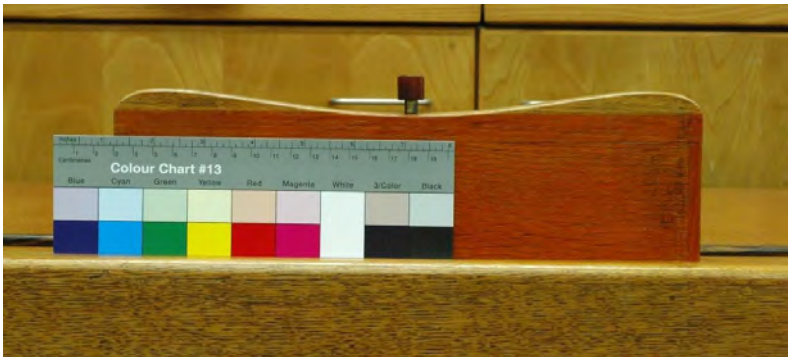


Figure 3 Detail of the buffet; the tray is pulled out and a bright orange colour is exposed. Photo: Jasmijn Groeneveld.
Figure 4 Buffet; by removing the upper part of the buffet a bright orange colour is exposed. Photo: Jasmijn Groeneveld.

Research is structured similarly for both case studies. After an introduction visual and technical research was carried out. Based on this a provisional goal for the colours of the piece of furniture was set. The colours of the projected light were then established and mapped on the object. Finally the result is discussed and evaluated.
Case study 1: the Kramer buffet

Where early Amsterdam School furniture is characterised by expressive organic and voluminous decoration this late Amsterdam School buffet is much more sober in design and decoration (figure 1). Originally, the bright monochrome orange colour gave the buffet its expressive appearance. The inside and some parts of the outside of the buffet, which have hardly or not been exposed to light at all, are still brightly coloured, while the rest of the outside has the colour of the oak substrate, with only a slight shade of orange (figures 3, 4).
Through visual analysis three stages of fading of the dyed colour were identified on the buffet: parts that have completely been protected from light, parts that have completely been exposed to light,

Figure 5 Three stages of degradation of the monochrome orange dye are set out: green: the orange colour has hardly changed, pink: these parts were often located in the shade and are still quite orange, blue: no orange colour is left; a slight orange shade can be recognised.

and parts that were often protected from light (figure 5). The oak substrate has darkened a bit over time too. This discolouration did not happen homogeneously, which is visible on, for example, the doors. Strokes of lighter and darker oak can be recognised (figure 1).

Technical analysis

Previous research carried out by the University of Amsterdam (UvA) has focused on three important elements concerning synthetic dyes, applied on Amsterdam School furniture. Firstly, through chemical analysis it was proven that anilin colourants were used to colour Amsterdam School furniture. Based on historical recipes reconstructions were made that showed that these types of dyes were originally characterised by their intense colours.[4] Artificial ageing of the reconstructions by exposure to light and to fluctuations in temperature and relative humidity gave insight into the lightfastness of these dyes. Results proved that most synthetic dyes exposed to light loose colour quickly. After being exposed to five years of museum lighting, the dyes containing, for example, diamond

Figure 6 Both the reference colour and discoloured parts of the buffet are visible. This photograph was used to perform colour measurements on.

green or methyl violet, had lost all colour.[5] The colour of synthetic dyes also turned out to change without the influence of light, yet much slower.[6] Previous research on the buffet proved that the discoloured orange dye was original and not the result of re-dyeing.[7] In order to determine the aspired colour to be projected on the buffet samples of the bright (not exposed to light) orange dye were taken and analysed through high pressure liquid chromatography (HPLC). Results showed that the dye is composed of 53.7% tartrazine, 38.5% Orange GG, 5.3% cochenille red A, and 2.5% of a Ponceau type. For our understanding reconstructions were made in which this same proportion of colourants was used. A concentration of 15 gram per liter created a similar orange colour as visible on the inside of the buffet.[8] Two important side notes need to be made. Because some synthetic colourants discolour quicker than others, the original proportion (and colour) might differ from the measured proportion. It is also important to state that the measured proportion of synthetic colourants does not give insight into actual concentration of colourants applied in the dye. It has so far turned out to be impossible to establish the concentration of colourants through documentation. This means that some uncertainty about the original colour remains.

Provisional goal

In order to study the potential of the method tested in this article a choice for an aspired colour needed to be made, but is is good to realise that this colour can be adapted afterwards. The colour on the inside of the buffet turned out to be the closest reference point (figure 6). The inside of the door is selected because the substrate is oak, just like the outside of the buffet, and it provides a nice homogenous and larger surface.

Originally, the buffet was dyed in a homogenous orange colour. In the text above it states that different shades of orange could be identified, as a result

Figure 7 Buffet, before recolouring, illuminated with white light.

Figure 8 Buffet, illuminated with coloured light.

of parts being exposed to partial or complete light or shade (figure 5). This heterogeneous discolouration will be recoloured through light projection to a homogenous result. The different shades in the oak substrate will not be corrected as they add to the patina.

Figure 9 Buffet, proper right side before recolouring with coloured light.
Figure 10 Buffet, proper right side, illuminated with coloured light to achieve the perception of a monochrome orange colour.

Setup, materials, software

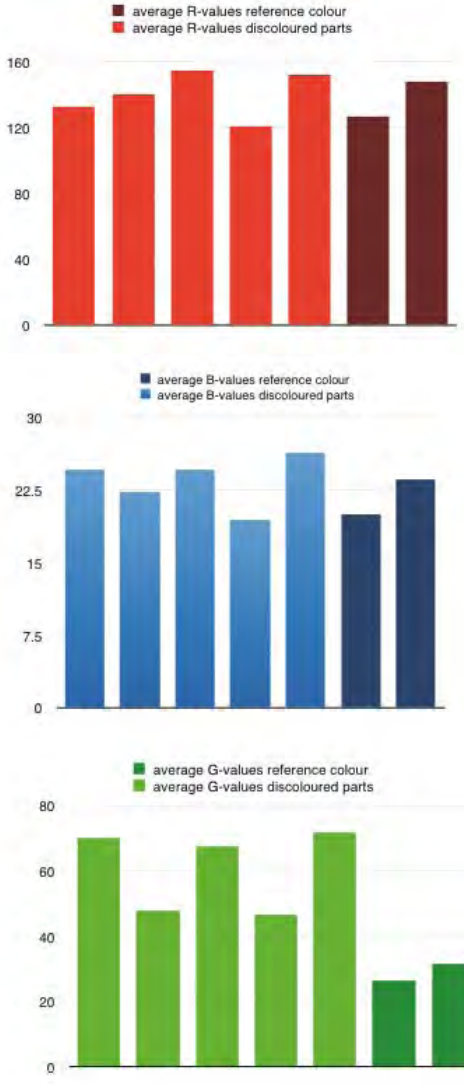
In this study we decided to use projection mapping software with beamers. Two relatively new, standard Epson EB-S9 presentation beamers from the UvA were available for use. It was decided to use one beamer per side; one beamer for the front of the buffet and one for the proper right side. The buffet is placed sideways in front of a white wall. This way the front side and the proper right side were clearly visible. In order to avoid disturbing reflection of all the light the beamers were placed under an angle at 2.10 meter height 3.9 meters away from the buffet. The room in which the buffet was placed was relatively dark; lights were turned off and only a little natural light (measured at a light intensity of about 30 lux) entered the room. Video Projection Tools 7 (VPT7), a free downloadable projection mapping program, was selected and installed on two laptops, which each controlled a beamer. The program is originally designed for use in the music industry. VPT7 is very user-friendly: shapes can be made and colour, expressed in RGB-values, can be assigned to these shapes. VPT7 has of course more functions but not all of these were necessary to use.

Method

Three experiments were used to develop a method which was then applied onto the buffet.[9] Because our perception is influenced by both the reflection spectrum of the object and the spectrum of the light the following statement can be made: the perception of the bright orange reference colour illuminated with white light should be identical to the discoloured outside of the buffet illuminated with coloured light.

In order to determine the colour of the coloured light it was necessary to quantify the discolouration first. These measurements were used to calculate the colour of the coloured light. Next, shapes were made in VPT7 that masked the discoloured outside of the buffet. Lastly, the calculated values of the coloured light were assigned to the precisely fitted mask. The same white light that was used during colour measurements was then used to illuminate the background and the reference colour. In the following text these steps are set out in dept.

Histogram 1 Average R-values, measured on discoloured parts (bright red) and on the inside of the door (dark red). Every bar represents ten measurements.
Histogram 2 Average G-values, measured on discoloured parts (bright green) and on the inside of the door (dark green). Every bar represents ten measurements.
Histogram 3 Average B-values, measured on discoloured parts (bright blue) and on the inside of the door (dark blue). Every bar represents ten measurements.



Colour measurements

While colour measurements in the field of conservation are often measured with a spectrometer, it was decided to use a digital photograph to do the colour measurements. A spectrometer consists of an internal light source that is different than the white light with which the reference colour and background were illuminated when discoloured parts were to be recoloured. In order to get information on the relative colour difference the whole buffet was illuminated with light with a RGB value of 0.75 on a arithmetic scale of 1. This white light was thought to be of a pleasant intensity and hue. A picture was used to do digital colour measurements on with the DigitalColor Meter Program from Apple (figure 6). The DigitalColor Meter program was set to measure the average colour of four pixels. Twenty measurements, expressed in arithmetic RGB values, were carried out on the inside of the right door. Because the oak of the outside of the buffet was less homogenous than the inside of the door, fifty measurements were taken to average the colour of the discoloured outside. In histograms 1-3 the measured R-, G-, and B-values are set out. Each bar represents ten measurements. For both the reference colour and the discoloured colour an average, a highest, and a lowest RGB value were determined.

Calculating the colour of the coloured light

It is previously stated that our perception of colour is both influenced by the spectrum of the light and the reflection spectrum of the object. Therefore the following equation can be drawn up:
Perception = RGB value light x RGB value object.

Because the goal is to make the perception of discoloured parts of the buffet equal to the reference colour it can be stated that:
Perception = RGB value white light x RGB value reference colour = RGB value coloured light x RGB value discoloured parts of the buffet.

The RGB values of the white light, set through VPT7, are known, as well as, after carrying out colour measurements, the reference colour and the discoloured parts of the buffet. Therefore, with

this equation the colour of the coloured light can be calculated:
RGB value coloured light = RGB value white light x (RGB value reference colour : RGB value discoloured parts of the buffet).

By carrying out the calculations with both the average, the highest, and the lowest measured RGB values a range for the RGB value of the coloured light is determined.[10]

R-range = 0.72 – 0.87
G-range = 0.20 – 0.50
B-range = 0.67 – 0.83

Projection mapping on the buffet

Using the projection mapping software program was quite straightforward. Masks were created in VPT7 and projected by the beamers. When the beamer was focussed well, a slight grid pattern made up of the pixels, typical for beamers, was visible from up close. By setting the beamer slightly out of focus this pattern was no longer visible at all. The shapes were fine-tuned during projection, so that they precisely covered the discoloured outside. The background and the reference colour stayed illuminated with the same RGB value of 0.75, which was also used during colour measurements. Within the calculated range, a RGB value of 0.87, 0.45 and 0.6, which is a pinkish colour, created a good match with the reference colour, illuminated with white light (figures 7, 8). While the range is quite large, it was experienced as a helpful tool as a good colour match was selected quickly. While variations in the colour of the oak were not corrected, the difference in the colours on the left side of the buffet, which was the result of partial shading from light, was corrected by projecting a slightly different RGB value (figures 9, 10).

Result and evaluation

The result was evaluated through measurements and qualitative perception research. Digital colour measurements were carried out on a picture that was taken of the achieved result (figure 8). Ten measurement on both the reference colour, illuminated with white light, and the discoloured parts, illuminated with coloured light, were carried out. The average RGB value of 131.9, 29.8 and 20.9 of the reference colour and an average RGB value of 138, 32.8, and 22.4 of the recoloured outside proved that a good colour match was achieved.
Lux measurements were carried out to determine whether the result met guidelines for museum

Figure 11 Chair, part of the same ensemble as the buffet, illuminated with white light. P. Kramer, 1933-1936, collection RCE, inv.nr. AB-25460-A. Photo: RCE.

Figure 12 Chair. The discoloured wood is illuminated with coloured light, while the rest is illuminated with white light.

Figure 13 Nightstand, part of the same ensemble as the buffet. Half of the nightstand is illuminated with white light and half with coloured light. P. Kramer, 1933-1936. Collection RCE, inv.nr. AB-25467.

Figure 14 Detail commode, two mounts are removed, which exposes brighter coloured tulipwood and purpleheart.

Figure 15 Detail of a primula flower on the commode; traces of sand-shading, engraving and colour are visible.

lighting.[11] The coloured light has a light intensity of 140 lux, which was found acceptable since the projected light wavelengths don't contribute to further discolouration.
The result was also evaluated by asking a group of ten conservation scientists, curators and conservators of the RCE and the UvA to answer a questionnaire of seven questions.[12] The questions focused on finding out whether the result was experienced as realistic and whether a difference in colour between the reference colour and recoloured parts and a difference in colour through light or through dyeing was observed. The response was very positive. The result was thought to be highly realistic and patina was kept. The orange colours were found to be identical. Projected light imitates a dye very well as it has the same transparent qualities. One of the conservators wrote: 'As a whole it gives a natural and balanced appearance. The difference between the more discoloured and well preserved parts is equalised to a degree that gives a *rustig beeld* [calm image] whilst preserving local variations that prevent "overkill" and give a natural effect.'
Because the result was found to be very satisfactory more objects from the RCE ensemble were 'recoloured' by projecting coloured light as part of a test exhibition at 'Bijzondere Collecties' (UvA special collections) in Amsterdam (figures 11-13).[13]
Case study 2: the Bongen commode

The bombé commode by Andries Bongen is decorated with a marquetry design of different flowers in a vase, a little butterfly, tropical wood veneers and gilded mounts. The object has been in the collection of the Amsterdam Museum since 1970. Bongen engraved his name in the marquetry on the frontside of the commode (figure 2). Dutch Rococo furniture makers often did not sign their furniture, which makes Bongen an exception.[14]
The commode has been dated back to 1766 because of an advertisement in the *Amsterdamsche Courant* of the fourth of December, 1766, that makes mention of two commodes; the commode in the collection of the Amsterdam Museum has been identified as one of them.[15] The advertisement gives clear insight into the fact that the commode originally had a different, coloured appearance. It states: 'By Bongen. Mr Kastenmaker, op het Spui, tussen de Voor-en Agterburgwal, zyn dagelyks te zien, en voor een redelyke pays te koop, twee Comodes, met gecouleurd Bloemwerk ingelegd; een Secretaire of Schryf Tafel, waar op 4 Kindertjes, verbeeldende de Negotie, ingelegd en gegraveerd: zynde deze Stukken naar Fransche wyze gemaakt, en kunden voor Kunstwerk doorgaan.'[16] [By Bongen. Cabinetmaker, on the Spui, between the Voor-and Agterburgwal, on view daily, and for sale for a fair price, two commodes, inlaid with coloured flower marquetry; a secretaire or writing desk, on which four children, depicting Trade, inlaid and engraved: these objects are made in French style, and could pass for works of art.] This advertisement shows that Bongen priced his own work by the fact that it is decorated with *gecouleurd Bloemwerk* [coloured flower marquetry]. The commode in its current state is appreciated, but since the original colours are lost it only partially represents Bongen's original idea.
Research on creating the illusion of a recoloured commode is still in progress. It this first test phase we have focused on recolouring the front of the commode through light projection. Mapping and recolouring the monochrome buffet was relatively

Figure 16 Frontside of a loosened sample of a rose for HPLC analysis.

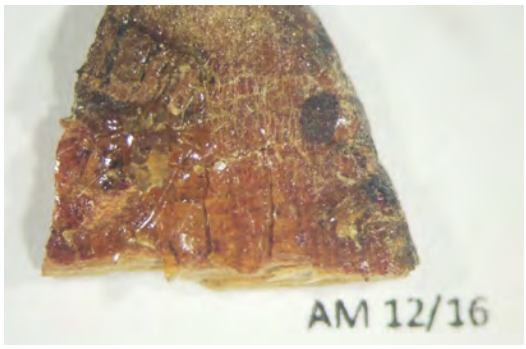


Figure 17 Backside of a loosened sample of a rose for HPLC analysis.

Figure 18 Provisional goal for the recolouring of the commode.

easy. It was interesting to determine whether fine details and multiple colours could be projected precisely onto the bombé front of the commode.

Visual analysis

In order to retrieve information on the original colours of the front of the commode, visual and technical analysis was carried out. Through visual analysis the tulipwood and purpleheart veneers were identified. By removing two pieces of the mounts that covered both the purpleheart and tulipwood it became visible that the veneers had lost their initial bright colour, which was to be expected after 250 years (figure 14). As a contrast, between the tulipwood and purpleheart a narrow strip of holly is applied. Holly was also used for the marquetry design. The commode is finished with a transparent finish, which was not further investigated.

While most flowers have discoloured to a light brown colour, some still showed a trace of a green colour (figure 15). It is possible that this green colour indicates an original blue colour of which the yellow components have discoloured. The leaves and branches, while also made of holly, have discoloured to a darker shade of brown than the rest of the marquetry. This could be the result of certain ingredients in the dye.

When analysing the marquetry it also became clear that the depicted flowers and leaves were originally engraved and that sand-shading was applied. Engraving and sand-shading marquetry designs was common practice in the eighteenth century, adding depth to the leaves and flowers. This increased, together with the colours, the realism of the depicted image. This realism had become an important element since the 1740s.[17]

Due to sanding some of the engraving and almost all of the sand-shading seemed to be lost. The engraving was probably originally filled with a black or coloured paste. Now the engraving that is still visible, yet very shallow, seems to almost have the same colour as the colour of the veneer (figure 15).

Because eighteenth-century marquetry artists aimed for realism, information on the types of flowers that are depicted and their likely colour is of importance to set a provisional goal. With the help of botanist Dr. Sam Segal it was tried to determine the types of flowers depicted.[18] The red roses (Rosa gallica), two types of yellow-orange narcissus (Narcissus tazetta aureus & Narcissus poeticus), red-pinkish papavers (Papaver somniferum) and blue primulas (Primula x pubescens) were quite easily and surely identified. While roses appear in multiple colours in the eighteenth century the most likely colour of these roses is red, as cultivated red roses became en vogue. Other flowers were more complicated to identify and multiple options were opted. For example, one type of flower could be an alpine clematis (Clematis alpina) or a vinca (Vinca major), both of which are a purplish blue. Also the white-yellow anemones (Anemone nemorosa) were not quite surely identified.

Technical analysis

In the past years, research on unraveling the original coloured appearance of marquetry furniture has been carried out. By studying historical documentations and recipes for eighteenth-century natural dyes reconstructions have been made, and our knowledge of the original appearance of marquetry furniture has improved greatly.[19] With this knowledge, combined with chemical analysis of colourants and metal compounds that can still be detected in veneers of marquetry furniture, digital reconstructions of the original appearance of specific pieces of furniture have been made.[20] But similarly to research on synthetic dyes, chemical research, such as HPLC analysis, does not give information on the concentration of natural colourants in dyes. Therefore, some uncertainty remains on the precise colour hue of these dyes applied on marquetry furniture.

Chemical analysis was carried out on the commode to identify colourants and metal compounds, yet no reconstructions, based on historical recipes, with these colourants and inorganic compounds have been made yet. Therefore, technical analysis was used to help support the botanical research that has been carried out. Based on these two elements a provisional goal was set.

Both X-ray fluorescence (XRF) and HPLC have been carried out on the commode. XRF gives insight into inorganic compounds, while HPLC analyses organic elements. For the HPLC analysis it was necessary to scrape some material of the back of veneers. It was decided to aim for a sample of each type of flower, the branches, the vase and the butterfly. Small pieces of veneer were carefully loosened and lifted from the commode. The backsides of these veneers provided interesting information. The backside of a veneer of the rose showed a red colour (figures 16, 17). Samples for HPLC analysis were scraped of the backsides of the veneers under a microscope. The veneers were then glued back with hide glue.

XRF analysis was carried out with a portable Bruker Tracer III.[21] Measurements were done directly on the commode, rather than on the removed pieces of veneer. It has so far proven to be difficult to filter relevant information from the results.

Provisional goal

Based on both the botanical knowledge and chemical knowledge of the colourants a provisional goal was set (figure 18). It needs to be stated that this goal should be seen as an educated guess - no further research on determining and reconstructing dye recipes has been carried out yet. In this stage it was found important to find out if it was possible to recolour the commode (with all its fine details) convincingly by projecting coloured light. Reconstructions of the dyes will be made in a later stage, the projected light colour can easily be altered accordingly.

Setup

In order to recolour the commode with coloured light the commode was placed in front of a white wall in an exhibition room at the Amsterdam Museum. The room was illuminated with a light intensity of 30 lux and no spotlights were aimed directly at the commode. At a height of 10 centimeters from the floor one standard presentation beamer was pointed at an angle toward the front of

Table 1 HPLC analysis. The results for the roses, papaver, primulas and vinca or alpine clematis are in line with the botanical identification. However, the results for the narcissus and leaves seem to contradict the botanical findings. The presence of metal compounds might be held accountable for this deviation, but the the XRF results still need to be fully understood.

Sample	HPLC results
Rose	Cochineal, unknown red components
Narcissus	Madder, emodin, unknown red components
Corona of the narcissus	Emodin, possibly alizarin, unknown red components
Primula	Indigo carmine, alizarin, unknown red components
Papaver	Cochineal, brazilwood
Alpine clematis/vinca	Indigo carmine, indigo, ellagic acid
Anemone	Alizarin, unknown yellow components
Butterfly	Unknown red components
Vase	Ellagic acid, madder, unknown red components
Narcissus leaf	Possibly emodin, possibly indigotin, unknown red components
Rose leaf	Ellagic acid, madder, possibly emodin

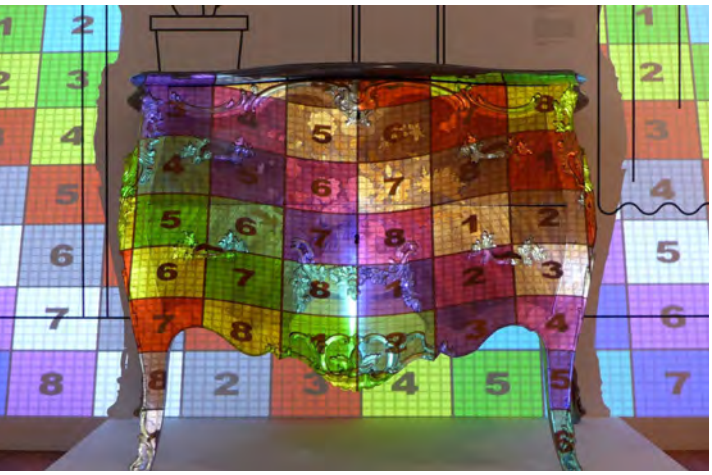


Figure 19 The projection of a grid onto the front of the commode demonstrates the distortion that occurs.

the commode.[22] The beamer, that was made available by the museum, has a short throw ratio of 0.52:1, which means that at a short distance of 52 centimeters from the commode a projection screen with a width of 100 centimeters is created. Because the beamer has a native resolution of 1280x800 and small details on the commode needed to be mapped out correctly, it was found important to use the resolution optimally. At a distance of about 80 centimeters away from the commode the whole front of the commode and a little of its surrounding background was covered by the projection screen. The beamer was fastened on a specially made pedestal, because any movement means realignment of the mapped image. The beamer was connected to a laptop whilst installing and fine-tuning the projection of the image.

Method and mapping

In case study 1 colour measurements and calculations formed the foundation for the RGB colour value of the projected light. In order to do these measurements and calculations the reference colour and the discoloured surface needed to be illuminated by the same light and then photographed. Because there are no reconstructions, in other words, no concrete reference points, made for the dyes on the commode it has not yet been possible to perform colour measurements and make calculations. This means that the projected RGB values are decided solely through visual analysis with the provisional goal in mind.

Projecting colours precisely onto the commode was complicated compared to mapping the buffet. Multiple colours needed to be projected precisely to create the illusion of a recoloured front. Some branches are only three millimetres in width. Projecting a non-warped, 2D recoloured image of the commode would not give a good fit due to the bombé shape of the front of the commode. The projection of a grid clearly shows the deformation that occurs (figure 19). The recoloured image needed to be warped.
It was decided to use a 3D scan of the front of the commode as the base for warping the projected image. This scan was made by Sander Mettes through photogrammetry with Agisoft Photoscan. It provided a very high texture resolution, which means that fine details, such as the grain of the wood, were visible on the scan (figures 20, 21).[23] In the texture of the scan masks for each group of flowers, the branches and leaves, the vase, the butterfly, the purpleheart, tulipwood, the strip of holly, but also the mounts were made. The masks were then rendered in 3Ds Max. In figure 22 the mask for the branches and leaves is shown.
The mask for the tulipwood asked for special attention. The tulipwood is now relatively monochrome, while originally there was more contrast. In the

Figure 20 The making of a 3D scan of the front of the commode through photogrammetry with Agisoft Photoscan. Photo: Sander Mettes.

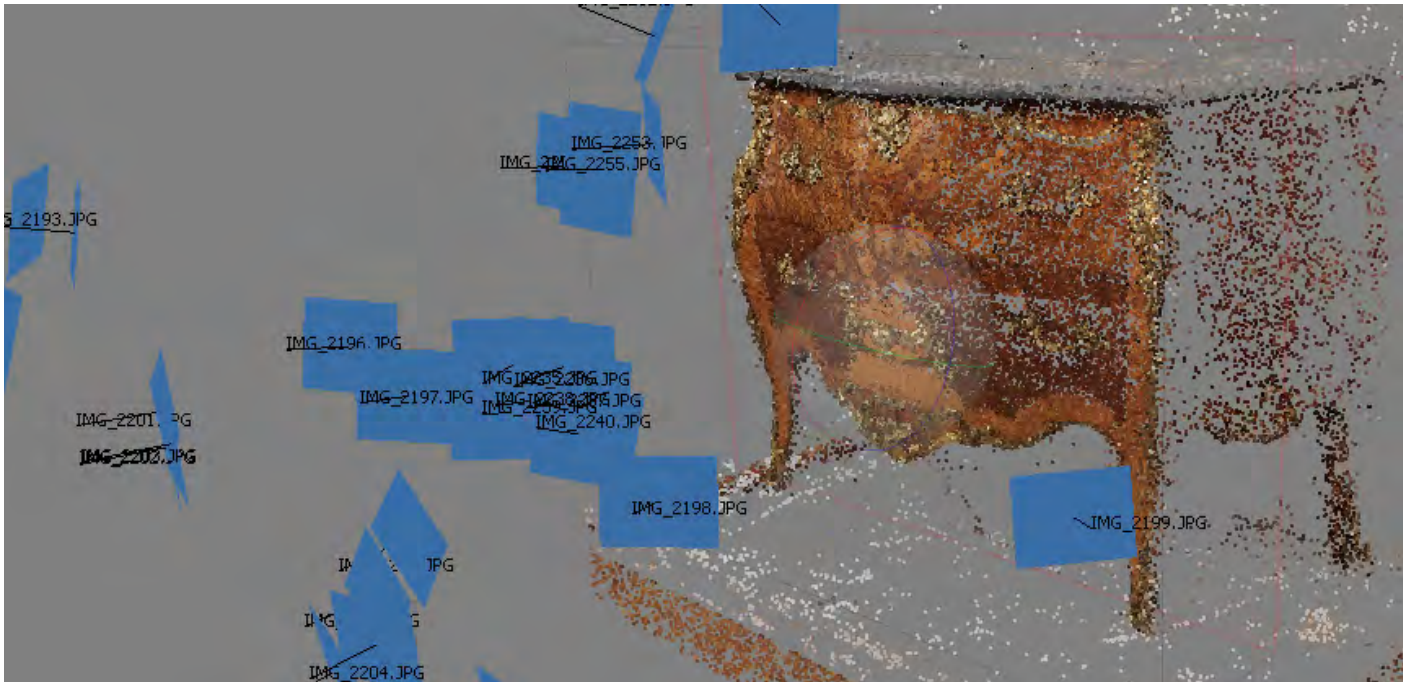


Figure 21 High texture 3D scan of the front of the commode. Photo: Sander Mettes.

Figure 22 For each element on the commode a mask was made. In this picture the mask for the leaves and branches is shown in white. Photo: Sander Mettes.

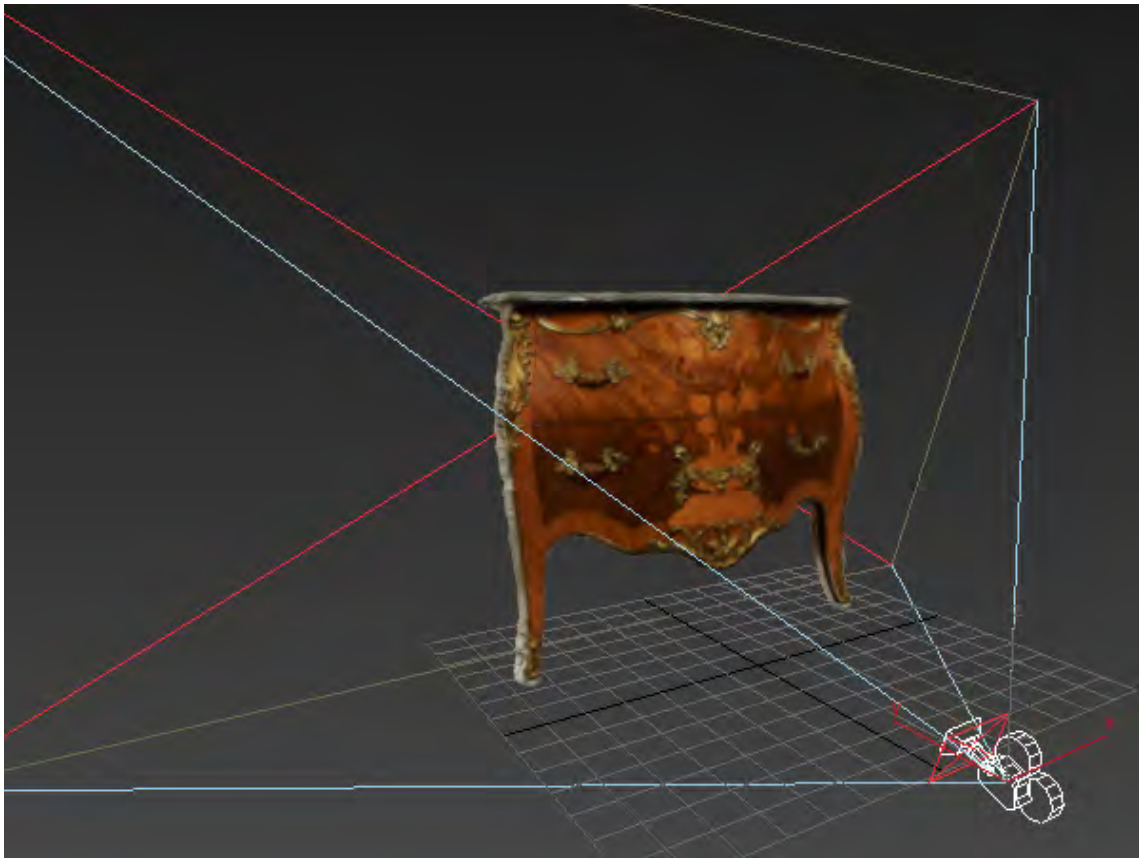


Figure 23 In the 3D scan a low viewpoint, imitating the location of the beamer, is chosen. Photo: Sander Mettes.

high texture 3D scan the slight difference in colours, still visible in the tulipwood, was highlighted. This was used to create a mask in which the typical straw-coloured background and pink streaks were added. Together all these masks formed the projected image. In Photoshop each mask can easily be assigned any RGB value.

In the rendered image a low viewpoint, imitating the viewpoint of the beamer, was picked (figure 23). By using Resolume Arena 5 Media Server, a software program with projection mapping functions, the distortion of the image was fine-tuned (figure 24). VPT7 was not used because warping could only be done to a limited standard and did

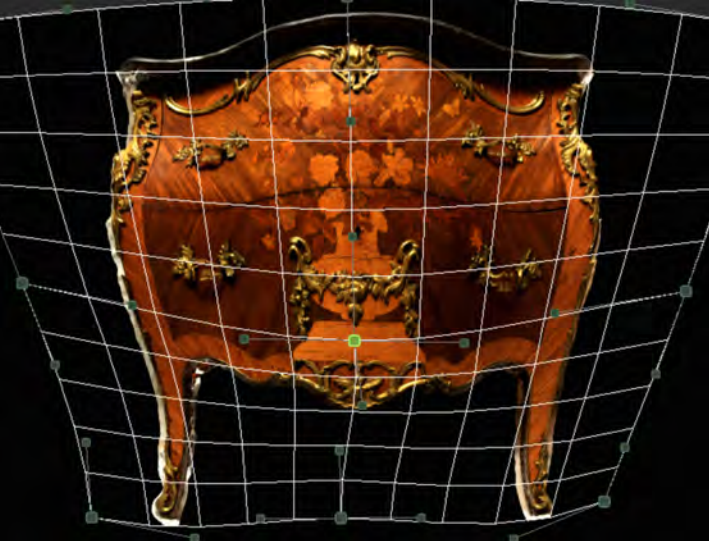


Figure 24 The fitting of the projected image is fine-tuned in Resolume Arena 5 Media Server so that it precisely masked the commode. Photo: Sander Mettes.

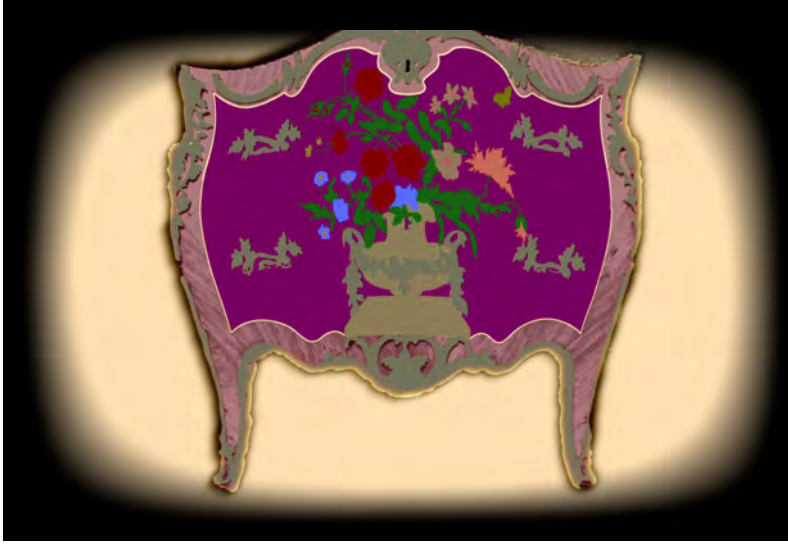


Figure 25 All the masks together make up the recoloured warped image that is projected.

not provide a sufficient result. Once the masks were projected and tested separately, the coloured image was projected (figure 25). Once the image fitted well the light intensity was lowered slightly to achieve a realistic result and acceptable light intensity levels (figures 26, 27, video 1).

In order to exhibit the projected commode at the Amsterdam Museum a loop of three files (a blank white page, the warped coloured image, and a no light page) was created. In this loop the recoloured image was set to show 30 seconds, while the other two slides showed 10 seconds. This loop was then placed on a SD card and put in a Brightsign 481010-13 to control the beamer.

Results and evaluation

The result is evaluated through visual analysis and through light intensity measurements. In this stage no qualitative perception research was carried out. The main focus was put on determining whether the projected image fitted well, and whether the result looked realistic.

Despite the limited resolution of the beamer the image fitted well, and details were masked precisely. Slight impreciseness can be detected from up close, but overall the steps that were taken resulted in a sufficient fit (figure 27). A slight displacement of the commode that happened when we were not testing caused an impreciseness in the projection, which highlighted the sensitivity of the setup. It turned out that the upper drawer had moved a little bit.

Setting the beamer slightly out of focus in case study 1 prevented the grid pattern that was caused by the pixels which made up the projected image and that was visible from up close. But since the multi-coloured projected image needed to be projected exactly onto the commode, setting the beamer slightly out of focus gave an imprecise result.

Figure 26 The commode, illuminated with coloured lights.

Figure 27 Detail of the commode, illuminated with coloured lights.

Video 1 The Bongen commode, illuminated with coloured lights.

Therefore the beamer had to be in focus, which creates a grid pattern that is slightly visible from up close. At a viewing distance of about 1.5 meters this grid pattern does not distract from the result. As explained before, the beamer was placed in front of the commode on the floor at a distance of about 80 centimeters. In this setup, due to the projection angle, all projected light is reflected straight to the eyes of the viewer. From certain viewing positions the result is less realistic than others. For example, a reflection of purple light could be visible when projecting purple on the purpleheart (figure 28). A better setup will correct this problem; we expect that attaching the beamer to the ceiling could correct this problem.

In the first case study it was found that the projected light imitated the qualities of a dye well; in case study 2 this was also the case. In this stage of the experiment the realism of the result was important; it was kept in mind that the set RGB values could be changed easily. As for the purpleheart and tulipwood the aspired result was known. The projected coloured light yielded a realistic result: the illusion of fresh purpleheart and tulipwood was convincingly created. The woodgrain remained visible, which added to the realism of the result. The projection of streaks of pink and a straw-coloured background created a good result onto the discoloured tulipwood.
The colours projected onto the vase, the butterfly, and the gilded mounts need to be improved. The mounts were lit with a slightly greyish cold colour of white light to create a more calming result. This was a wrong choice because the colour of the mounts partly lost its warm gold appearance. This can easily be improved by changing the colour of this light from cold white to warm white. More research is necessary to improve the colour of the butterfly and the vase.
In this stage it is difficult to evaluate the accuracy of the projected colours of the branches, leaves and flowers, but the result does provide useful information. It is clear that the illusion of bright colours can be achieved. Creating a strong illusion of white-yellowish flowers caused difficulty because the surface is light brown. The flowers are still a little light yellow-brownish. We succeeded in creating the blue, green, red and pink colours. Colour contrast was sufficient but could be improved. By dimming the beamer its colour output and light intensity decreased. A larger colour output could be reached by the beamer when the projected light is not, or less, dimmed, but this would also increase the light intensity, which could make the result look less realistic. More research is necessary to achieve an optimal balance.
Lastly, after creating the illusion of a recoloured marquetry design the flowers and leaves were experienced as very two dimensional. The loss of sand-shading and engraving became clearly visible, more so than when the commode was not recoloured. It would be interesting to investigate whether it is possible to reconstruct this through projection mapping.
Aside from a visual evaluation, lux measurements were carried out in order to judge wether the projected light met guidelines for museum lighting.[24] The white light that was used for illuminating the background was measured at 140 lux. The purpleheart was illuminated at 45 lux, the leaves and the branches at 55 lux. The overall light intensity was found acceptable.
It can be concluded that recolouring the discoloured commode through light projection has proven to be a promising method. Different colours can be reached and fine details can be mapped correctly onto bombé shapes. A realistic result was achieved and light imitated the qualities of fresh tropical woods and dyes well as the grain of the wood stays visible.

Conclusion

Results have shown that light provides a good and promising alternative for recolouring faded pieces of furniture in museum settings. A method with a series of steps has been developed, from doing colour measurements, colour calculations, visual and technical research, making a 3D scan and using projection mapping software. Recolouring the monochrome buffet has shown to be straightforward. The result was found to be highly realistic and lux levels were acceptable. Where a physical restoration is not considered an option, but a more accurate representation of the original appearance is aspired, light can provide a useful solution. Recolouring the bombé commode has proven to be more complicated, but the results so far are promising. Further research is necessary to improve the accuracy and realism of the result.

Further research

Further research will focus on two aspects: researching and making reconstructions, and optimising the technical setup. By making reconstructions of the dyes a better and more accurate (provisional) goal can be set. With these reconstructions colour measurements can be carried out to calculate

a range for the RGB values of the various masks. When fine-tuning the colour of the projected light it would also be interesting to investigate whether it is possible to reconstruct and project the lost engravings and sand-shading. It will be challenging to actually project such detailed lines and to set a goal for the engraving and sand-shading. A reconstruction of the engraving and the sand-shading might be done based on the remaining engraving and sand-shading on the commode and on other pieces of furniture by Bongen.
In both case studies standard beamers have been used. In case study 1 a good result was achieved with these beamers. In case study 2 a standard beamer provided a sufficient resolution and colour range, yet both could be improved. In this study a small budget was available, so using the standard beamers was a good choice. It would be interesting to find out whether a better overall result can be achieved with a high-quality beamer. Also, being able to use more beamers would make it possible to recolour all sides of both objects. Generally, more expensive beamers provide a higher resolution and larger colour range in combination with a higher light intensity. When imitating the qualities of a dye a high light intensity could result in a less realistic result. Also, the guidelines for museum lighting might not be met. While it is possible to dim the light intensity this also means that the colour output becomes smaller. In other words, less light means a smaller colour range. Through tests it could to be determined whether it is possible to reach a balance between these elements with a high-quality beamer.

Creating the illusion of certain colours depends on the colour that is aimed for, the colour output of the beamers, but also on the colour of the substrate. The bright colours of both the buffet and commode have faded to light brown, which makes it relatively easy to recreate the illusion of bright colours again. But there is a point where the colour of the substrate is too dark for realising a light and bright colour. Creating tests in which the colour of the substrate differs, could help determine the limitations of this technology. We hope to continue this research in 2018.

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Notes

[1] Vienot, F., e.a., 'Leds as a tool to enhance faded colours of museum artefacts'. In: *Journal of Cultural Heritage*, volume 12 issue 4, 2011.
[2] Stigter, Sanneke, 'Verkleurde kleurenfoto's: Restauratieproblematiek in het werk van Ger van Elk', *kM* nr. 50, 2004, pp. 54-56.
[3] Owens, H. & Perkins, R., 'Henry VIII's Tapestries Revealed. The science behind the project. How 21st century technology brought a five hundred year old tapestry back to life', Manchester University, 2009.
[4] Bommel, M.R., E. Fantini. 'Het kleurenpalet ontrafeld: Reconstructies en analyses van synthetische beitskleurstoffen'. In: Vasques Dias, Miko, red., *Kleur bekennen. Conservering en restauratie van de kleur van houten meubelen*. Amsterdam: Stichting Ebenist, 2013, pp. 46-62.
[5] Timmer, J. & Bommel, M. van, 'Synthetische kleurstoffen als beits op hout. Een onderzoek naar de ontkleuring'. In: Vasques Dias, Miko, red., *Van School tot Stijl. Modernisme in de meubelkunst 1915-1940*, Amsterdam: Stichting Ebenist, 2015, p. 10.
[6] Timmer, 2015, p. 12.
[7] Groeneveld, J., 'Verkleuring en ontkleuring van synthetische kleurbeitsen op hout. Een zoektocht naar de originele laag'. Unpublished thesis, UvA, Amsterdam, 2014.

[8] Groeneveld 2014, p. 160.
[9] In my Master's thesis these experiments are discussed in-depth. see: Adrichem, F. van, 'Licht op Kramer. Het retoucheren met licht van ontkleurde anlinebeits-afwerkingen op monochrome Amsterdamse School meubels'. Unpublished Master's thesis, 2015.
[10] F. Ligterink, conservation scientist at the RCE, helped drawing up these equations.
[11] Brokerhof, A.' *Lichtlijnen. Het beperken van lichtschade aan museale collecties*. ICN informatie nummer 13, 2005, p. 10.
[12] The questionnaire, including answers given, is discussed in-depth in: Adrichem, F. van, 'Licht op Kramer. Retoucheren met licht van ontkleurde anlinebeitsafwerkingen op monochrome Amsterdamse School-meubels'. In: Vasques Dias, Miko, red., *Van School tot Stijl. Modernisme in de meubelkunst 1915-1940*, Amsterdam: Stichting Ebenist, 2015, p. 18.
[13] In 2015, we exhibited a nightstand and a chair for four months at the special collections department of the University of Amsterdam. Museum visitors could fill in a short questionnaire. Most people experienced the result as realistic.
[14] Baarsen, R., 'Andries Bongen (ca. 1732-1792) en de Franse invloed of the Amsterdamse Kastenmakerij in de tweede helft van de achttiende eeuw. In: *Oud Holland*, jaargang/volume 102-1988, nr. 1, p. 24.
[15] Baarsen 1988, pp. 27-28.
[16] Baarsen 1988, p. 27.
[17] Baarsen 1988, p. 28.
[18] Dr. S. Segal is a botanist specialised in identifying flowers in seventeenth-century and eighteenth-century still lives.
[19] Michaelsen, H. & Buchholz, R., *Vom Färben des Holzes. Holzbeizen von der Antike bis in die Gegenwart*. Petersberg: Michael Imhof Verlag, 2009
[20] Heginbotham, A. e.a., 'Revelations of Color in the Marquetry of J.F. Oeben'. (Conference Poster) at: The Decorative: Conservation and the Applied Arts. IIC Congress, Vienna , 2012.
[21] XRF analysis was carried out by Han Neevel, conservation scientist at the RCE.
[22] A Vivitek D857 450080-05 projector was used.
[23] Sander Mettes works for Cre8 and specialises in 3D scanning and printing. Sander provided a rendered 3D scan of the front of the commode.
[24] Brokerhof 2005, p. 10.