Figure 1: Overall view of eighteenth-century French table (museum catalogue No. F110), before conservation.

UV Light Photography as an Aid in the Conservation of Eighteenth-Century Furniture

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Abstract: The Wallace Collection houses, among thousands of extraordinary artifacts, beautiful and rare examples of 18th-century French furniture. In recent years some of the pieces decorated with intricate marquetry work have deteriorated and caused concern among the conservators and curators of the museum. One piece in particular, a little toilette and writing table, appears in urgent need of attention. The surface has darkened considerably and the decoration is obscured. In 1995 several professionals, including Gregory Landrey, Director of Conservation at the H.F. du Pont Winterthur Museum, examined and analysed this object. Ultraviolet light analysis was also conducted to locate the pollutants on the surface.

The purpose of this paper is to discuss how photographic records of the UV analysis were taken and used as an aid in the conservation of this object. The scarce literature on photography of artifacts under ultraviolet light forced Richard Valencia, professional photographer, and myself to test various possibilities. The photographic results which were considered acceptable were later supported by similar results obtained from tests carried out by Christopher Swan, furniture conservator at the Colonial Williamsburg Foundation.

The Museum and Eighteenth-Century Furniture

THE WALLACE COLLECTION IS A NATIONAL museum in the heart of London. The collection was formed between 1780 and 1880 by three generations of the Seymour-Conway family, namely Francis Charles 3rd Marquess of Hertford, Richard 4th Marquess of Hertford and his illegitimate son Sir Richard Wallace. They assembled what is probably the most outstanding collection of French furniture of the period 1685–1800 in Great Britain. The collection was bequeathed to the British nation in 1897 by Sir Richard's widow, Lady Wallace.

Deterioration

Exposure to sunlight and to random fluctuations of relative humidity and temperature has in the past caused degradation of some artifacts on display in the Wallace Collection. These unfavourable conditions were improved in the late 1970s when air conditioning regulated by a computerized system was introduced in the galleries; precautions were also taken against sunlight through the installation of blinds and UV filters on the windows.
Unfortunately some pieces of furniture had already suffered from adverse environmental conditions resulting in considerable damage to the surface, and in a few cases to the structure.

Previously furniture was often treated with a polish "reviver" consisting of pumice powder and linseed oil which was rubbed on the surface until most of the finish was removed. Subsequently, a new layer of polish was applied to the surface, often aided by a few drops of linseed oil to achieve a lustrous finish. Sometimes a layer of beeswax, dissolved in turpentine or similar solvent, was applied to the surface. These various treatments are documented in the museum's restoration books which show that many pieces of furniture in the collection were treated this way two or more times in the last 100 years. In the late 1970s a gallery attendant was dismissed for applying a home-made remedy, con-

sisting of cinnamon oil and glycerin, to a piece of furniture in the collection. It transpired that he had treated several pieces of furniture in this way.

Bio-deterioration, the chemical degradation of the materials applied during treatments and the physical effects of dusting and restoration techniques, all contributed to the damage caused to artifacts. F 110, the piece which was the smallest and probably in worst condition of all, was chosen as a representative object.

Description of the table F110

F110 is the museum catalogue number for a toilet and writing table which was made in France around 1763 possibly by Leleu. The table has one drawer on each side and two at the front, all lined with blue silk, and accessible upon releasing a double-throw lock with a key. This also allows the table top to slide back and the top drawer to slide forward revealing inkwell holders and a writing slide, the underside of which accommodates a mirror.
The table is decorated with gilt bronze mounts and is made of oak veneered with various woods such as sycamore, tulipwood and pear. These woods were originally very colourful, some naturally and others artificially coloured. The veneer on the writing slide still retains its original colour as it was never exposed to sunlight for extended periods of time.

Analysis of the table

Since its acquisition by the 4th Marquess in 1864, the table has been restored twice, in 1929 and in 1942. Both times the surface was treated with pumice powder and linseed oil in order to remove the old finish. The surface was subsequently coated with several layers of button polish in 1929, and with beeswax in 1942. Details of the treatment are sparse and no further treatments are recorded in the museum's books. However, the table must have been treated again, as on visual inspection it appeared to be coated in glossy shellac.

The table was visually examined both in visible light, to assess the state of the surface, and later in UV light, to characterize the materials present on the surface. The front of the table appeared particularly stained and the decoration obscured by a dark and patchy finish, which under UV light fluoresced dark brown suggesting the presence of aged and cross-linked oils. The surrounding areas and one drawer fluoresced slightly orange indicating a shellac finish.

The same materials were present on both sides of the table, although with a different pattern and concentration from the front. In fact, the dark patches were present mainly along the bronze mounts.

The back appeared in relatively good condition. The finish was uniform, glossy and fluoresced orange. The state of the finish and the total absence of dark patches was due to the fact that the table has always been displayed against a wall preventing damage.

The top of the table caused the most concern. It appeared badly disfigured by a long crack running across the top dividing the flower basket motif into two parts. The marquetry decoration appeared lifeless due to a degraded shellac finish and to a particularly serious staining especially of the pieces of light coloured woods which appeared stained dark brown and often cupped or cracked. In some areas only the cracks were stained, thus producing a streaky effect. In UV light, the center of the top appeared dark brown with a semicircular dull black area right across the flowers above the crack suggesting that it was subjected to either repeated dusting or polishing. The rest of the surface, mainly the edges, appeared greenish indicating thin and aged shellac, with only one small area fluorescing slightly orange, where the finish had been protected against sunlight by a museum label.

The UV light visual analysis had shown the presence of oils on most of the surface. It was important, at this point, to establish if they just lay on the surface or if they had penetrated the substrate, and if so, to what extent.

Tiny samples of wood, measuring less than 1 mm^2, were taken from the top of the table, along the crack, and from the back in the proximity of the missing piece of marquetry. The two areas were selected for different reasons:
• representation: the sample from the top was to represent the worst condition, as opposed to the one from the back where the surface was in relatively good condition.
• convenience: the top was already damaged by a

big crack, and the back had an area of loss. Tiny samples could be taken without any risk of disfiguration.

The samples were examined with an Olympus BH-T Series microscope with a UV filter. The cross-sections of the sample from the top of the table show remnants of a plant resin varnish, dirt, and some pumice powder (or rottenstone) on the surface. There are also some oils which seem to have penetrated into the wood grain. The sample was stained with DCF (2,7 Dichlorofluorescein). Its yellow fluorescence indicates the presence of unsaturated oils, i.e. comparatively fresh linseed oil or cinnamon oil. The cross-section of the sample from the back shows remnants of a plant resin varnish trapped underneath an uneven layer of shellac on top of which dirt, dust and pumice are present. This layer was stained by DCF, producing a yellow colour, again indicating the presence of unsaturated oils.

A sample of the surface coating was taken by slightly scraping the central area of the top, and analysed with GC-MS (Gas Chromatography-Mass Spectrometry) to characterize its nature. The results showed that oils and waxes were present on the surface, but no trace of glycerin was found.
The same type of analysis, carried out on samples from other pieces of furniture in the same condition and from the same gallery, indicated the presence of glycerin. The absence of glycerin from the table sample might be accounted for if the sample area was not representative of the whole object.

UV light

It is important, at this point, to talk about the basic principles of fluorescence of materials. The electromagnetic spectrum includes:
- infrared light, invisible to the human eye;
- visible light
- ultraviolet light, invisible to the human eye.

The shorter the wavelength, the higher the energy of the radiation; UV light is more energetic than visible light. When a substance is irradiated with exciting light, some of this light is absorbed and produces energy. Part of this energy is then emitted as light, or fluorescence, while the rest is converted to heat. Organic materials are particularly affected by this energy but in general we can say that they are more damaged by a combination of shorter wavelength irradiation and longer exposures.

A substance absorbs exciting radiation and emits radiation, almost always, of a longer wavelength. This is demonstrated by the fact that it is possible to see the fluorescence, or emitted light, of a substance but not the exciting light, or UV light, which irradiates it.

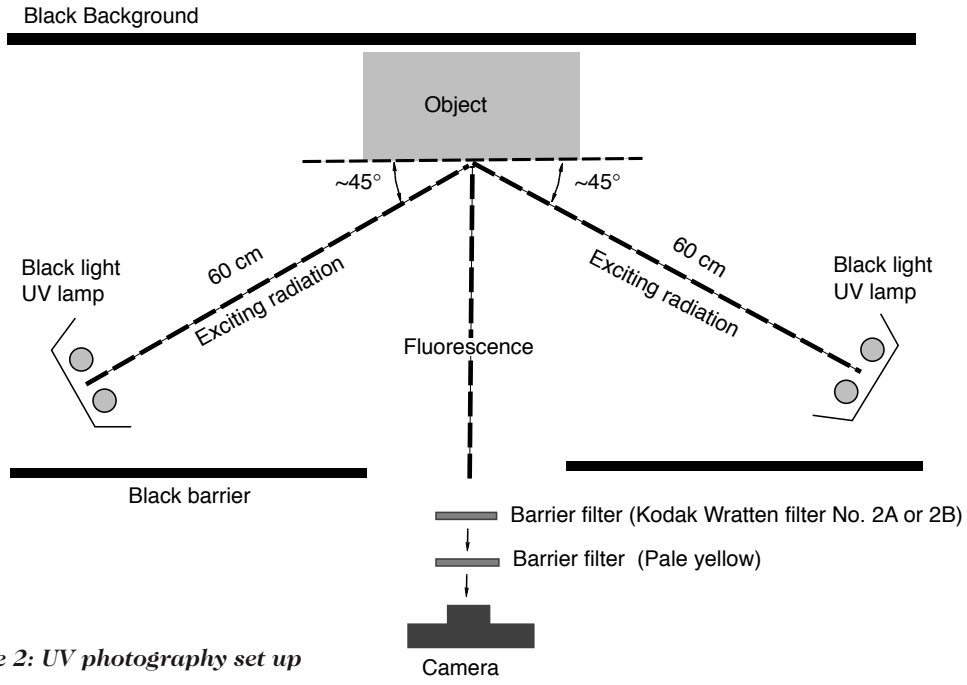


Figure 2: UV photography set up

Figures 3 & 4: The top of the table before conservation, viewed under visible light (left) and UV light (right)

Fluorescence of most substances is excited by long wave UV-A and part of medium wave UV-B, or wavelengths in the range of 400-300 *nm*, but UV-A emission lamps should be used for analysis of organic materials, as they are the least damaging.

"Black Light Blue" (BLB) fluorescent lamps, which emit only in the UV-A waveband, were chosen for the examination and photography of the table. BLB tubes are made of normal soda-lime glass with the addition of cobalt and nickel oxides.

UV photography

UV light photographic tests were carried out in a darkened room. Black cloth was used as background for the UV light photography to eliminate unwanted light and to improve the signal-to-noise ratio.

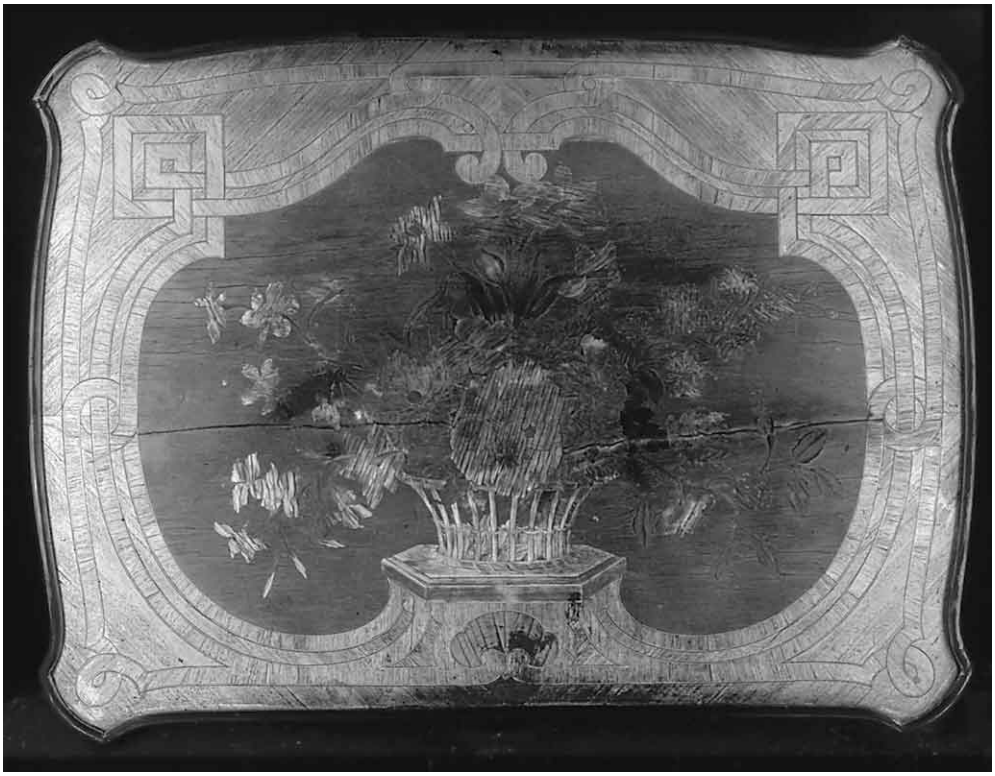
Black cloth barriers were placed behind the UV lamps to screen out as much direct radiance of UV light as possible from the camera. Two BLB lamps were placed in front of the table at an angle of about 45° and one on each side.

A pale yellow barrier filter was placed on the camera lens to reduce, but not eliminate, the amount of blue light recorded by the film, by absorbing wavelengths below 425 *nm*. As the yellow filter may fluoresce under UV, it should be screened with a non-fluorescent filter. A Kodak Wratten filter No. 2B can be used to eliminate such fluorescence. This filter has a slightly yellow tint which is designed to remove a little violet light. *(fig. 2)*

Daylight colour films, which have a balanced sensitivity to blue, red and green colours, were used to record the colours of the fluorescence. Also, 100 ASA films were chosen as they give better quality definition results than 200 or 400 ASA.

Exposure time depends on:
- intensity of radiation source;
- distance of source from object;
- fluorescence brightness;
- speed of colour film.

The photographic tests were carried out with both a large format camera and with a standard 35 mm



camera. The best results and most accurate colour reproduction were achieved under the following conditions:

Large format camera:
Film: 100 ASA Daylight Ektachrome 10x8 EPN (or 5x4)
Exposure: 20 minutes (or 10 minutes)
Aperture: F 11.5

35 mm camera:
Film: 100 ASA Daylight Ektachrome EPM 35 mm (slide) or 100 ASA Colour Negative Film C41 (print)
Exposure: 2 minutes
Aperture: F 5.6 $^{1/2}$
The prints produced were used for reference during the conservation treatment or the table, and are an important document for the future.

Cleaning

The decision to remove all the finish from the surface was based on the fact that the finish was not original and was causing damage to and disfiguration of the marquetry. It was however decided to leave untouched parts of the table, such as the back and the inside elements, since they were in reasonably good condition and served as records for future conservation.

The removal of the glycerin was considered a priority in the cleaning process as it caused or at least contributed to swelling and cupping of some pieces of marquetry. Glycerin is hygroscopic, and its other characteristics are: volubility in water and many solvents; capacity to attract dust and dirt, not evaporating.

Cleaning tests, carried out on the table top, proved that the pollutants present on the surface were water soluble. It was decided that the whole surface of the table should be cleaned once with a water based system and subsequently examined to determine the next step in treatment. As the surface of the table, especially the top, already appeared very damaged, a gelled system would be more advantageous in:
• maintaining contact between the solution and the surface;
• preventing water from being absorbed by the wood;
• allowing application of the cleaning agent on restricted or vertical areas.

Figures 5 & 6: The top of the table after the third cleaning, viewed under visible light (left) and UV light (right).

A gel, prepared with de-ionized water and 8% Laponite RD, a synthetic inorganic colloidal clay with a pH 8.0-8.5, was effective in removing much of the pollutants. Upon completion of the first cleaning, the surface of the table top appeared in a better condition when examined both in visible and UV light.

The dark and dull area, shown in UV light in the centre of the top, had been removed and the light coloured pieces of the marquetry were now visible, but not completely cleared of the dark pollutants, and it was decided to carry out a second cleaning with the same gel. As a result, a great improvement in the appearance of the surface was noticed: most of the cracks had been cleaned and the light coloured woods appeared in better condition.

Still, a few areas appeared a bit patchy and some remnants of polish were present on the surface, especially along the edges. The UV light analysis revealed remnants of a shellac coating on the edges of the top, some oily deposits along the front edge, and a dark patchy appearance on the top part of the central panel.

The surface needed further treatment, as uniformity was sought. Two gels were tested on the edge of the top: the Laponite RD gel and an Ethanol gel. As expected, the Ethanol gel worked very well in removing all the shellac residues, while the Laponite RD gel did not work at all. The opposite results were observed on the central panel where no shellac was present. The top was cleaned with two gels used on different areas. The result was that the surface appeared clean and uniform both under visible and UV light and the contrast between the different types of woods was restored. The cleaning process was thus considered complete and the table ready for further analysis and treatment. *(figs. 3–6)*

Conclusions

The pollutants on the surface of this table were obscuring the marquetry and causing degradation. It was important to remove them and to restore the visual appearance and to prevent further degradation of the marquetry.

Microscopic cross-section analysis, Gas Chromatography-Mass Spectrometry and UV light analysis

proved invaluable in the characterization of the substances at the root of the problem. The analytical results combined with cleaning tests were effective in determining an appropriate cleaning method which didn't damage the fragile surface.

The use of a UV light proved very helpful for assessing the effectiveness of the cleaning process and is a low cost option for conservators who do not have ready access to a UV microscope to check their cleaning process with cross-section samples taken after cleaning.

This conservation treatment sets guidelines for the conservators of the Wallace Collection in the treatment of other pieces in the same condition, subject to analysis.

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