Hungarian University of Fine Arts Doctoral School
DLA dissertation

Color changes of intarsia images of pieces of art over time

Kinga Enikő Papp
2018
Supervisors:
Dr. habil, DLA professor emeritus Péter Menráth
Dr. Sándor Fehér PhD, associate professor, SOE SKK

The thesis of the dissertation

The theme and purpose of the dissertation

The focus of my dissertation is the distortion of the color of wood intarsia on pieces of art over time, with particular reference to the biological, chemical, physical causes, possible variations and degrees of these changes.

The hypotheses of the dissertation are as follows:
H1: In the tree, the biological and chemical processes are linear as a function of elapsed time, which means the longer the harmful light and heat effects the wood, the more the original color is damaged
H2: Color variations of different species occur in different ways.
H3: The darkening of originally light colored woods is darker than the darker trees. The graying and yellowing of the originally dark colored woods is stronger than those of the light trees. The contrasts and color differences between light and dark woods are decreasing over time.
H4: Biological and chemical processes are influenced by the way in which wood is processed, with particular regard to the cutting directions (eg strong differences can be found between tangential and radical directed cut).

Structure of the thesis

The first step in the research was the compilation of a chronological furniture line, from the 18th century to the 20th century, with 23 different-aged furniture. The aim is to investigate the H1 hypothesis: to examine the understanding of linear and non-linear time dynamics of the color changes before the instrumental colorimetry.

The H2, H3 hypotheses are analyzed by sampling from 11 pieces of artwork. I took samples from several different places within an intarsia. Identification of the type of wood was done through intersection and 3D scanning. Samples were tested under a stereomicroscope - in this case the layer structure and possible extra colorants were determined/identified by examining the cross-sectional grinding in UV and normal light. Thereafter, instrumental colorimetry was made on the samples with coated and uncoated surface. Surface coatings were identified by optical microscopy and Fourier transformation, IR spectroscopy examination.
I test the hypotheses above by documenting the restoration of two pieces of art. The Renaissance chest held by the Kuny Domokos Museum and a Carlton House desk were expanded with fresh wood, then I aged the new veneer with UV shield to the color of the object.
In order to investigate the H4 hypothesis, we have taken different pruning locations and different cutting patterns of two species. The transformation of these wood materials and the samples were examined with the use of various surfactants under natural glass and glasses with different foils in order to formulate the appropriate piece of art protection recommendations.

Finally, through the reconstruction of the two intarsia images taken from the sample line, I present the difference between the aesthetic experience of fresh woods compared to the color of aging pieces of art. The examination of the assumptions is based on and complemented by the theoretical literature research in the history of art and restoration.

Methods and results

1. *The result of the tree species definition.*

The samples from the veneers of intarsias of the furnitures were used to define the tree species after a slim cut using a 3D scanner. The accurate knowledge of wood materials has highlighted the technique of intarsia making: the use of homogeneous textures and similarly light colored tree species refers to a colored, painted intarsia image. When making an intarsia image, contrasting imaging is always performed. This is achieved by the color, design and structure of the different wood, or by staining, painting. The paintings of antique furniture with intarsia are now yellowish brown and have a pale brown color. We can see a homogeneous picture, and at a glance it can not be said that when the furniture was still in full splendor whether the pieces of the intarsia were shining in their own color or in the color of the pickling.

Studies showed the technical differences. The microscopic shots of the samples and normal and UV shots from the cross-section of the embossed samples showed the pigments of the painting in the wood and the result of the analysis of the wood species could be deduced from the original color of the veneer.

2. *Results of layer structure and FTIR tests*

The examination of the surface-coating material of the sample furnitures was done by optical microscopy and Fourier transform FTIR spectroscopy. The IR spectroscopic testing of the surface coating material was shellac polar for every object. As a result of the FTIR test, shellac coatings were detected on each surface of the objects studied, suggesting that the earlier-dated furniture was overlaid over time.

On the outer surface of each sample, a layer of coating (varnish) was visible, which was also visible on the normal and UV shots of the sample under the stereomicroscope. In my cases, on the back of the samples a color dye layer was observed, the composition of the paints was not analyzed, because the research did not focus on the coloring dyes.

The presence of paints justifies the assumption that the same tree species used for the elements of the intarsia do not give colored or contrasted pictures in themselves, it is achieved by staining. Over time, the homogeneous intarsias that decorate the furniture can be divided into two groups, according to which the original colored veneers fade, yellow and become nearly one color, while the other group has the same or nearly uniformly homogenous tree species of intarsias that can be easily painted. In the case of veneers belonging to the same tree species - when the marinade or dye decays - the different shapes can not or can hardly be distinguished by their color.

3. *Bútorok lakk és lakk nélküli felület színmérési vizsgálatok eredményei*

I have completed the examination of the given intarsia samples on the original or subsequent coatings and on the uncoated surfaces of selected pieces of art.

As a result, it was possible to find a well-distinguished surface layer on the samples taken from the intarsias of the furnitures by looking at the recordings of embedded samples with stereomicroscopic normal and UV filters. The contemporary color of the various types of motifs can be observed, which I examined with and without the surface varnish. I compared the colorimetric data of the two surfaces and determined the color difference. As a result, I got a "big" or "clearly visible" category. Taking into account the results, it was found that the shellac coating on the surface of the objects was darkened, giving a protective film to the furniture and below the veneers were less degraded.

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The results of the measurement of each intarsia element can be influenced by the dye inputs during the curing process. This can be an overriding reason to avoid using different retouching materials on original veneer surfaces during restoration.

My results showed that there was a high color difference between the varnished and natural veneer surfaces, while the color-calibrated surfaces of the restored chest and the natural surfaces showed stagnation.

Aging of different sections of two tree species, results of tests

The original (fresh) color of the trees differs from the 100 to 200 year old changed color of the same species.

I applied exact test methods to validate the hypothesis. Exposure of the various veneers was investigated before, during and after UV radiation, before, during and after use of the Xenon chamber, and before, during and after 120 ° C, 160 ° C and 200 ° C thermal radiation. The parameters of the results of the test methods were recorded by color measurement.

For the examinations, I took different pruning locations of different tree species, with different cutting directions. I studied tangential and radial beech veneer, tangential walnut veneer and walnut burl veneer for color variations with various environmental exposures.

The changes of these wood material were also carried out in the presence of various surface treatments. I divided the several pieces of plywood sheets into equal strips and applied different surface treatment materials to each. The order of the strips applied on the surface coatings:

1.-control adhesive tape; 2.-natural surface; 3.-shellac polur; 4. bleached beeswax; 5-copal; 6. rosin.

Samples with different coatings were also studied under uncoated glassware and glassware with different foils in order to formulate the appropriate piece of art protection recommendations. Sunlight exposure tests have been carried out with a natural window glass, a "museum" NUV65 SR PS4 foil window and also an IQue 73FG foil window. As a control indicator, I used a piece of the original veneer, which I stored in a refrigerator chamber until the end of the test.

I performed the physical aging of the selected tree species - in which various light and temperature changes and cycles have been examined - and the examination of the interactions of certain coatings on the given tree species.

4. *Result of aging test in UV box and Xenon chamber*

Physical aging of the selected tree species in the UV box and Xenon chamber, with different surface coatings, different foiled glasses and glasses without foils, are also examined for up to 72 hours of treatment time.

I found that the color changes of the examined veneers after 6-14 hours UV radiation do not yet show visible results but can be measured. Significant color changes can be observed after 24-35 hours and drastical changes after 48-72 hours. Each of the jar veneer darkened. In the 72-hour treatment period, the change in color happened mostly in the case of the radial section of the maple. However, the change was drastic for 6-10 hours, then slowed down gradually. In the case of walnut and walnut burl, yellowing and fading were the same. The highest change occurred after 10 hours of UV radiation and steadily increased. The brightness factors of the different species did not change after different UV radiation. After a couple of hours of treatment, the walnut burl changed most, after 10-14 hours, the veneer belonging to each species showed a steady and continuous change.

After treatment of the exposed veneers with UV radiation, the color change, which was visible or large, was closely related to the treatment time, which was visible or large.

The degradation of surfaces with different coatings also differed. On the jar tangential sectional veneer, the coatings showed a uniform aging, while on the radial section of the jar the waxy coated part showed the greatest color change. In the tangential section of the walnut burl and the walnut, the shellac also showed a big difference beside copal.

5. *Test results of accelerated aging in UV box and Xenon chamber*

I found that the varnishes in the Sapratin climatic cabinet with xenon lamps after 24 hours were already noticeable, after 72 hours they became drastic. Each of the jar veneer darkened. This was mostly noticeable on the radial section of the maple. The change in the first 24 hours was drastic, then slowed down but rose.

In the 24-hour treatment, the change of color was most significantly yellow and red, with a 72-hour xenon lamp, the change in light was significant. The degree of color change was closely related to the treatment time or was large. With the increase in exposure, the light factor changed most. The light veneers darkened, while the darker and more elaborate trees were gray and homogenized.

The degradation of surfaces with different coatings also differed. On the basis of the measurement data, on the jar tangential sectional veneer, the coatings showed a uniform aging while the wax-plated section showed the largest difference in color difference on the radial section of the jar. There was a large variation in the coat on the walnut burl, and the tangential section of the walnut showed steady degradation. The slightest difference in color was given by the shellac, which is due to the fact that it gives an orange dark color to the tree.

In the Sapratin climatic cabinet, I used a xenon lamp under glass sheets with different foils. After 72 hours of xenon lamp, the change in clarity on the four types of veneer under the spectral selective films of the IQue 73FG film did not increase significantly, under the glass panel "Museum" NUV65 SR PS4 increased minimally. In close relationship with the treatment time, on the basis of the measurement data, the degree of color change was noticeable or clearly visible, with no apparent change to the IQue 73FG film, while in the case of the "Museum" NUV65 SR PS4 film it was minimal. In case of the latter film, the coat and the shellac coating had a large color difference. In the veneer below the natural glass, the degree of color change was visible or large, it was noticeable with the naked eye as well. In the case of veneers below the natural glass, the different coatings showed a nearly uniform color difference.

6. *Result of thermal aging test*

Compared to the initial stage in thermal studies, a color change of the same intensity can be observed at all varieties at 120, 160, and 200 ° C. After one hour of treatment, the radial section of the maple, then its tangential section, changed the most.

At a temperature of 160 ° C, the color change was mainly yellow and red, at 200 ° C the change of light was the primary factor. The degree of change varied by species.

At 120 ° C, it needed one hour until the color change became visible. The minimal change is hardly visible in the maple, and at other trees it is not. When treating the examined veneers at 160 and 200 ° C, the color change was closely related to the treatment time, which was visible or large. With the rise of temperature, the light factor changed most.

The degradation of surfaces with different coatings also differed. On the tangential section of the maple veneer, the coats showed a uniform aging at all three tested temperatures while the coarse coated part exhibited the greatest color change on the radial section of the jar. In the tangential section of the walnut burl and the walnut, the shellac also showed a big difference. There was a remarkable change on the surface of the walnut burl, the darkness of the shellac, almost burnt and became black.

It was possible to establish, for each aging process, that the measured values were closely related to the treatment time, color changes were influenced by the anatomical direction and location of the tree. Compared to the initial stage, color change of similar intensity was observed in all species with each of the surface treating materials. The largest change in the veneer was visible on the radial section of the maple. In the case of walnut and walnut burls veneers were yellowish and fading. With the increase in exposure, light veneers darkened, while the darker and more elaborate trees became greyish and homogenized.

7. *Restoration technique and result*

I have developed a technique that can be applied to the present restoration ethics by rethinking existing restoration techniques. First, I've done furniture restoration with a veneer repair

process. The advantage of this method is that the addition can be carried out on uncoated surface and while maintaining the surface varnish as well. In the case of the intarsia additions I made, the first important step was to define the veneer species and the direction of the cut. The selected veneer plate was sanded correctly to the direction and thickness of the joint surface. I put the prepared wooden panels in the UV box. After 4-6 hours, I compared the original and the aged surface with naked eyes, of course together with the varnish or wax test. In all cases, I cut the veneers to check how deep the aging went inside the tree. When I noticed a color identity on visual inspection, I continued to age the panels for another 2-3 hours.
The finished panels were burnished with fine sandpaper (1000) until color identity. I cut out the missing intarsia element from the raw material made, and I glued it to the missing place. When gluing, I used a plexiglass, or just mechanically wrapped it on the surface, taking care not to leave recesses or tool marks on the veneer piece. I applied lacquer or translocation on the surface.

This procedure is very simple, ethical and cost-effective. Conditions include defining a tree species and an UV box. The first is not a question today: during restoration a tree identity is identified for a supplement. The UV can also be homemade. Color identity can be checked with a colorimeter.

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