Table 1 – Solvent Testing for Overall Linseed Oil Reduction

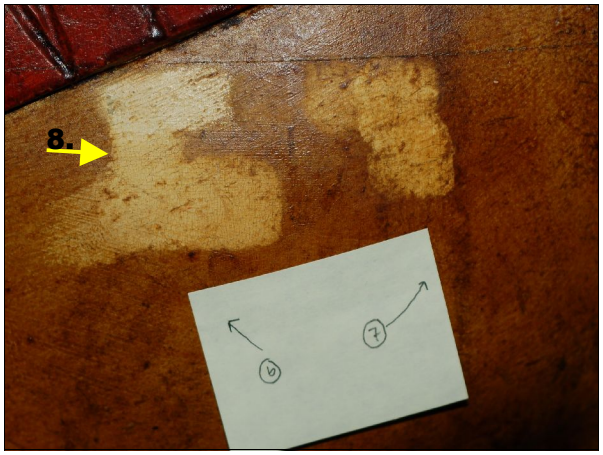
Paint Color in Area Tested	Solvent / Gel / Emulsion Used	Notes
White and tan body	Deionized Water (pH 6)	Swab turned slightly brown, no perceptible impact on linseed oil coating.
	Ethanol	Linseed oil is very soluble in ethanol, test successfully revealed a white paint layer. Works quickly.
	Acetone	Revealed white paint layer, removed linseed oil unevenly. Linseed oil became tacky with application of acetone, swab worked like an eraser.
	2% Ammonium Citrate in Water	More effective than water but still no perceptible impact on linseed oil coating. Remains active on surface – more oil comes up when area is cleared with water.
	5% TEA in Water buffered with Citric Acid to a pH of 7.5	More effective than 2% Ammonium Citrate in Water but worked slower than ethanol. Slightly uneven removal of linseed oil coating.
	Carbopol Gel 200 mL Deionized Water 2 g Carbopol 10 mL TEA 10 mL Citric Acid	Not as effective as Ethanol. One application effectively removes majority of linseed oil, slightly uneven.
	Pemulen Gel – EtOH 100 mL Deionized Water 10 mL TEA 3 mL Ethanol	After application of gel linseed oil becomes sticky and rough. Removes linseed oil more unevenly than the Carbopol gel.
	Benzyl Alcohol Pemulen Emulsion 2 g Pemulen 200 mL Deionized Water 10 mL TEA 10 mL 2% Tris in DI H_2O 20 mL Benzyl Alcohol	After application of gel linseed oil becomes sticky. Effect is similar to the Carbopol gel - slightly uneven.
	Benzyl Alcohol Pemulen Emulsion 2 g Pemulen 200 mL Deionized Water 20 mL TEA 10 mL Benzyl Alcohol	Slightly uneven effect. Leaves a residual coat of linseed oil on the surface.
	Pemulen Gel – TEA 2 g Pemulen 200 mL Deionized Water 20 mL TEA	Removes linseed oil evenly. Easy to control the effectiveness of the gel.
	Pemulen Gel – TEA, Tris 2 g Pemulen 200 mL Deionized Water 10 mL TEA 10 mL Tris	Removes linseed oil evenly. Not as effective in areas where oil is more heavily applied.

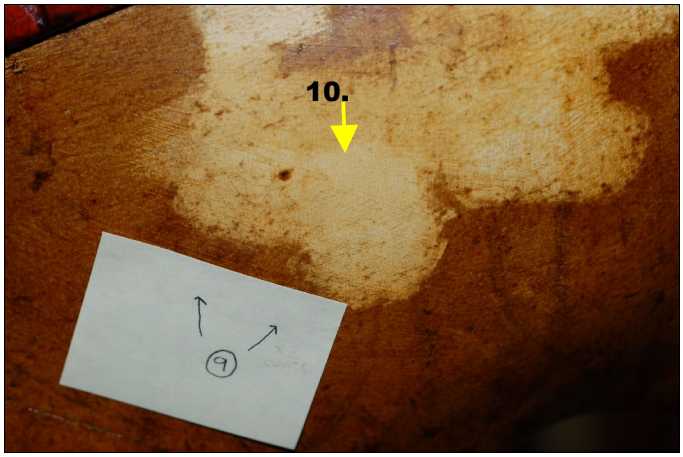
Paint Color in Area Tested	Solvent / Gel / Emulsion Used	Notes
Blue, yellow, and black paint on tack straps	Pemulen Gel – TEA, Tris	Effective – does not disturb original paint. Works slowly, is easy to control but requires two applications to satisfactorily reduce linseed oil. Black paint is somewhat sensitive to prolonged contact with gel.
	Pemulen Gel – TEA	Worked faster than the TEA, Tris combination. Safe to use on blue and yellow paint. Black is sensitive to extended manipulation.
	Pemulen Gel – EtOH	Worked faster than the TEA alone. Blue and yellow paint is not sensitive, but black is. Okay to use on blue and yellow areas with thick drips of linseed oil.
Red fringe below blue, yellow, and black tack straps	Pemulen Gel – TEA	Worked too quickly. Not very easy to control. Red is sensitive.
	Pemulen Gel – TEA, Tris	Worked slower than TEA alone, but still worked to quickly to control. Red is slightly sensitive.
	Pemulen Gel 2 g Pemulen 200 mL Deionized Water 10 mL Tris + 2 mL TEA to a pH of 7.0	Easier to control. Works slower than TEA, Tris combination. If gel is applied and removed quickly, the red is not sensitive. Buffer solution (TEA, DI H_2O, citric acid pH7) seems to do most of the work removing the linseed oil.
Rosy pink color inside the nostrils and mouth, white color on teeth	Pemulen Gel – TEA	Easy to control. Paint is not sensitive after extended gel manipulation on the surface.
Dark reddish-brown mane	Pemulen Gel – TEA	Paint is not sensitive after extended gel manipulation on the surface. Safe for multiple applications.
	Pemulen Gel – EtOH	Paint is not sensitive. Used in areas where linseed oil was particularly thick.
Salmon color on saddle	Pemulen Gel – TEA, Tris	Some linseed oil comes up on the swab, but is not noticeably effective.
	Pemulen Gel – TEA	Effectively removes linseed oil but requires multiple applications.
	Pemulen Gel – EtOH	Some minor blanching occurred, mildly effective in removing linseed oil.
	Benzyl Alcohol Pemulen Emulsion (10 mL Benzyl Alcohol)	Removed linseed oil but blanching occurred.
Dark red, yellow, and orange paint on saddle blanket	Pemulen Gel - TEA	Worked too quickly, not easily controllable. Reds are soluble.
	Pemulen Gel – TEA, Tris	Worked quickly. Red is not soluble if gel is applied and removed quickly.
	Pemulen Gel – Tris + 2mL TEA	Is not noticeably effective in removing linseed oil.

Solvent Testing Photodocumentation

Initial solvent testing area outlined in yellow
Proper Left, Plain Side front leg

1. Deionized water pH 6 **2.** Ethanol **3.** Acetone **4.** 2% Ammonium citrate **5.** 5% TEA solution in deionized water buffered to a pH 7.5 with citric acid



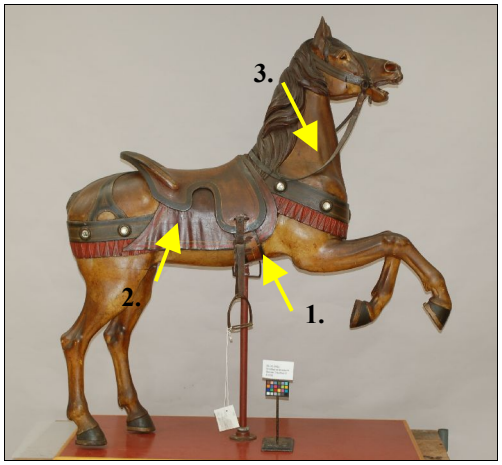


6. Carbopol TEA, citric acid gel **7.** Pemulen gel – EtOH **8.** Pemulen gel – Benzyl Alcohol 20 mL **9.** Pemulen gel – Benzyl Alcohol 10 mL **10.** Pemulen gel – TEA

Table 2 – Solvent Testing for Localized Linseed Oil Removal

Solvent	Notes
Acetone	Works well to remove large drips. Red paint slightly sensitive after extended exposure. Does not cause blanching.
Ethanol	Causes immediate blanching. Does not seem to be effective in removing oil.
1:1 – Ethanol : Deionized Water	Mildly effective in removing oil. Blanching occurs after evaporation.
Isopropanol	Effectively removes linseed oil without blanching. Works slower than the acetone.
1:1:1 – Ethanol : Acetone : Isopropanol	Not very effective. Slight blanching occurs after evaporation.
1:1 – Acetone : Isopropanol	Works fairly well. Slow and easily controllable. Red paint is slightly sensitive after extended exposure.
5% Ammonium Citrate	Was mildly effective. Red paint is slightly sensitive.

Cross Section Microscopy

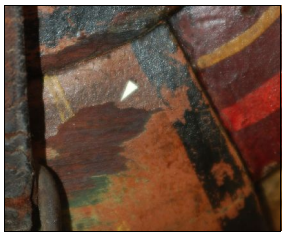


Obtained three samples for examination. Samples 1 and 2 were taken from areas with evidence of overpainting. Sample 3 was taken from an area with no evidence of overpainting for comparison.

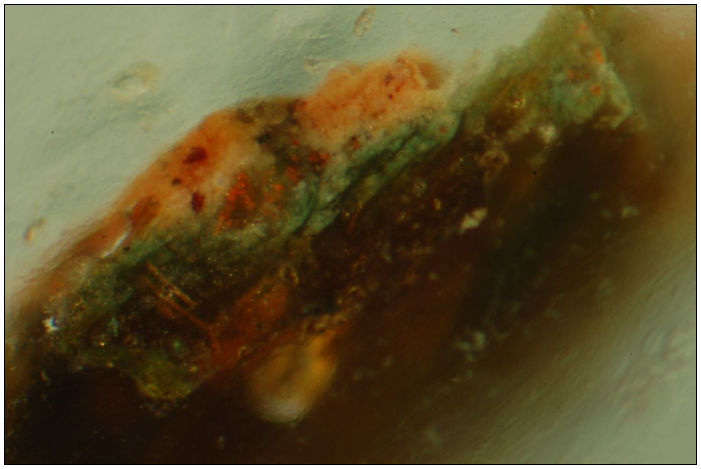
1. Sample obtained by Objects Conservator, Nancie Ravenel from an area of paint abrasion on the underbelly tack strap
2. Sample obtained by Lauren Bradley from the edge of a wood join seam on the saddle blanket
3. Sample obtained by Lauren Bradley from the edge of a wood join seam on the neck

I expected to find only one layer of colored paint in Sample 3 and two distinct layers of colored paint in Samples 1, 2, and 2b. Two samples were taken from the saddle blanket (Sample 2 and 2b) because the initial sampling attempt (Sample 2) yielded a sample that was too small to be of value. The small sample was mounted in epoxy for mounting practice.

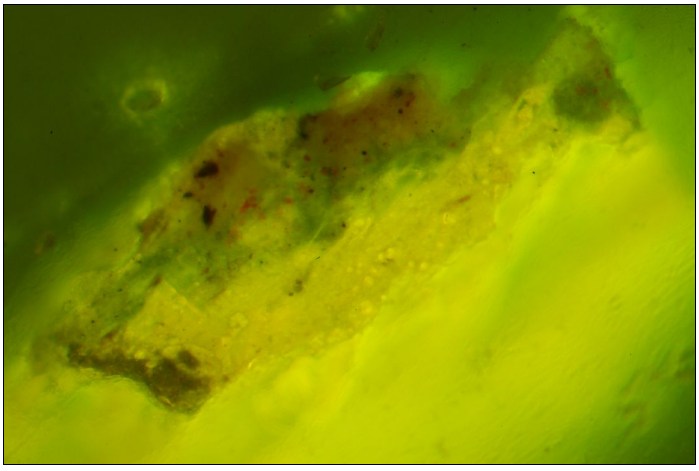
Sample 1




Before sample extraction, After sample extraction



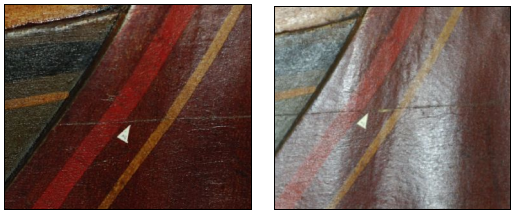
Sample in normal light under 10x magnification



Sample in ultraviolet light under 10x magnification

Prior to mounting Sample 1 in epoxy, it was possible to see wood, a green layer, a white (ground?) layer, a peach layer (possibly?), and linseed oil. After mounting and polishing it was possible to see dark brown wood, a green layer, a white layer, a peach layer, and linseed oil. The bright orange particles observable in the photomicrograph are not part of the sample and were probably deposited on the surface during polishing.[1] The dark red particles observable in the peach and white layers may be pigments that did not fully disperse into the binder when the paint was prepared. There is no evidence of an initial ground layer, which is unusual for a Dentzel carousel figure. The absence of grime between the green layer and the white layer is also unusual if the white layer and peach layers are assumed to be later additions of overpaint.[2] The uppermost layer in the sample fluoresces white in ultraviolet light, which is consistent with linseed oil. This thin layer protrudes down into the peach colored layer. Some dirt and grime appear to have accumulated in this protrusion.

Sample 2 and Sample 2b



Before sample extraction, After sample extraction

Prior to mounting Sample 2b in epoxy, it was possible to see wood, a blue-green layer, a red layer, and linseed oil. Unfortunately, the sample was damaged during mounting or preparation, which made it impossible to accurately interpret the stratigraphy. Under 10x magnification, the damaged sample has evidence of a blue green substance, a white substance, and bright orange polishing residue.

Sample 2 was polished after Sample 2b was damaged. Prior to mounting Sample 2, it was possible to see wood, a blue-green layer, red granules, and linseed oil. Unfortunately this sample was also damaged during preparation and was therefore impossible to interpret accurately. Under 25x magnification the damaged sample has evidence of a blue-green substance and bright orange polish residue. There is also a hazy, milky-yellow substance present that fluoresces white in ultraviolet light, which is consistent with linseed oil.

Sample 3

Before sample extraction, After sample extraction

Prior to mounting Sample 3 in epoxy, it was possible to see a white layer, linseed oil, and blue-green granules. After mounting and polishing it was possible to see some evidence of dark grime (?) embedded within a dark brown layer, a light orange-brown colored layer, and a white layer. A deposit of white polishing residue obscures the lower portion of the sample, which appears to be a nondescript shade of blue-gray(?). When viewed in ultraviolet light, the uppermost white layer has a layer of dark fluorescence atop it and a layer of bright white fluorescence below it along where it meets the orange-brown colored layer.

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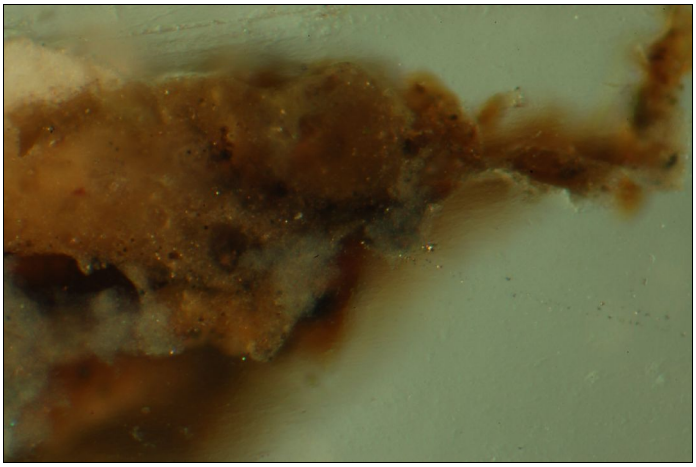
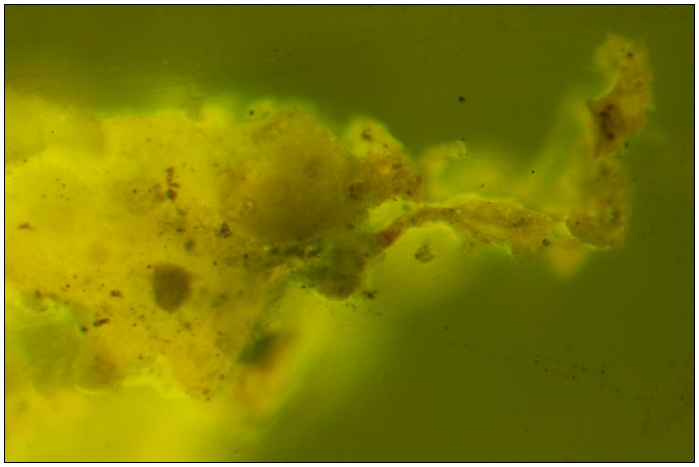
1 A suggestion put forth by Objects Conservator Nancie Ravenel.

2 Paint layers that are exposed to the air for an extended period of time before being overpainted accumulate a grime film, which usually shows up as a distinct layer in a cross section.

The dark grime-like layer could be indicative of overpainting. This conclusion, however, does not make sense when considering the color of the layers surrounding the grime – a bluish layer coated with a series of brown and white layers. Dentzel carousel animals were realistically rendered and painted, meaning a blue-gray horse would be an unlikely occurrence. It is possible that some of the grime-like material present in the cross section is actually a putty or filler used to fill the gap between two joined pieces of structural wood. Another explanation is that the unusual grime striations are due to the sampling location, along a crack in the paint. Grime may have penetrated the paint stratigraphy along an exposed edge.



Sample 3 in normal light 10x magnification



Sample 3 in ultraviolet light, 10x magnification

Conclusions

The cross sections reveal inconclusive evidence. The green layer in Sample 1 is not necessarily an initially exposed paint color as was originally assumed. The green could be interpreted as a primer layer in the absence of a white ground. The lack of grime between layers, and the fact that factory applied primers often had a nondescript tinge further supports this conclusion.[3] The presence of a second primer coat, a white layer atop the green layer, however, is not addressed in this analysis.

I expected to find two distinct layers of colored paint in Sample 2: the red color visible on the surface and the darker, blue-green color revealed in areas of abrasion along the edge of the ruffle. When considering the stratigraphy found in Sample 1, it is possible that Sample 2 may have yielded a similar absence of white ground. The blue-green revealed in areas of abrasion on the saddle blanket is strikingly similar in appearance to the blue-green revealed in the underbelly tack strap where Sample 1 was obtained. After the overall linseed oil reduction, a blue-green color became visible in areas of wear and abrasion on the saddle seat, and in an area of loss in the red ruffle, which would suggest that the horse was primed with an overall coat of blue-green paint. This theory can be used to account for the blue-green globules in Sample 3 that were visible prior to mounting and polishing.

3 Objects Conservator, Nancie Ravenel suggested that primer coats applied in the factory sometimes have a murky, nondescript color because they were simply a mix of the leftover decorative paint colors.