SHELBURNE MUSEUM

P.O. Box 10
Shelburne, Vermont 05482
www.shelburnemuseum.org
802.985.3346

Department of Preservation and Conservation
Examination and Treatment Report

Acc. No.: None
Conservation No.: 08-05-2492
Cat. No.: FC - 7.35
Owner: Shelburne Museum
Date Examined: June 3 - 4, 2008
Title: Carousel Horse
Structure: Painted wood, leather straps, iron stirrups and fasteners, brass appliques, glass ornaments and eyes, natural horsehair tail
Artist/Country: Gustav Dentzel workshop, Philadelphia, PA
Date Completed: July 11, 2008
Signature/Date: c. 1902
Conservator: Lauren Paul Bradley
Accessories: Red painted steel rod with flange and fittings
Labels/Legends: A small red tag tied to the proper left bridle ring has the number "7.0" inscribed using graphite. A rectangular white tag tied the proper left iron stirrup has the inscription "Temporary ID Tag / Permanent # to be / attached when / conservation treatment / completed" written in graphite on one side and "FC 7.35" written in graphite on the other.

Digital Photographic Documentation:

File Name	Description of Image
CO200852492A1	Before Treatment, Plain Side Overall
CO200852492A2	Before Treatment, Romance Side Overall
CO200852492A3	Before Treatment, Romance Side Face Detail
CO200852492A4	Before Treatment, Romance Side Detail
CO200852492B1	During Treatment, Detail of Face and Neck
CO200852492B2	During Treatment, Detail of Plain Side Ruffle
CO200852492D1	After Treatment, Plain Side Overall
CO200852492D2	After Treatment, Romance Side Overall
CO200852492D3	After Treatment, Detail of Face and Neck
CO200852492D4	After Treatment, Romance Side Detail

Reason for Treatment: To reduce the discolored linseed oil coating applied as a misguided maintenance measure. Lynn Miles gifted the treatment of this carousel horse to her sister Beth Stowell as part of the Adopt-a-Carousel-Animal program. Beth and Lynn chose to name the horse Spirit.

Building Location: Circus Building

EXAMINATION

The horse is one of forty animals belonging to a 1902 Gustav Dentzel Carousel purchased by Electra Havemeyer Webb in the early 1950s. Webb's purchase included all of the carousel's carved wooden animals, the chariots, the carousel organ and carved painted facade, the rounding boards that decorated the exterior of the carousel, and the painted textiles that enclosed the carousel's mechanism. The carousel, which is currently disassembled, was a three-abreast machine with animals positioned in rows of three around the platform.

Similar species were probably grouped together, although the carousel armature no longer survives. Tigers, giraffes, goats, deer, and lions are among the animals represented. The presentation side of the animals, which would have faced outwards for a spectator to appreciate, is the proper right side and is termed the "romance" side. Alternatively, the proper left side is termed the "plain" side. In general, the romance side has more elaborate carvings and ornamentation. The final carving work has been attributed to Daniel Mueller, the Dentzel workshop's master carver. Dentzel animals are noted for being the most realistically carved American carousel animals.[1]

The horse is a "prancer", a term that describes an animal with at least two of its feet lifted off the ground. On this horse, the two front legs are lifted high in the air; the proper right hoof extends outward while the proper left one curls towards the ground. The horse has a horseshoe on each hoof. Small incised lines are visible on the horseshoes on the two raised front hooves. The horse is relatively small in size and is probably from the innermost row on the carousel.[2] It measures 52 inches in length from the front hoof to the tail, 10 inches in width, and 59 inches in height from the ground to the top of the ear.

The horse is mounted to a red platform with a light wooden trim that is 50 inches long, 26 inches wide, and 2 inches deep. A painted red metal pole 1 ¼ inch in diameter is used to anchor the horse to the platform. The pole enters the underside of the horse through a small circular opening slightly wider than the pole and exits on the horse's back between the front of the saddle and base of the mane. There is no cap covering the metal pole.

Similar to the other animals in the carousel menagerie, the horse is constructed out of several blocks of wood, which were selected based on the wood's working properties, hardness, and grain direction. The pieces were carved individually, laminated, and most likely assembled using glue and dowels.[3] The inside of the horse's body is hollow.

A thick, uneven coating of discolored linseed oil obscures the readability of the painted colors. When the horse entered the lab, it appeared to be a caramel brown color. Its head cocks slightly to the right and its stylized, wavy, dark brown mane is combed entirely towards the proper right, romance side. Three forelocks of mane fall through the horse's pointed ears and spread across its forehead. Its eyes are glass and yellow in color with black pupils. The area surrounding the eye socket is painted pink. Its nostrils are flared and its mouth is wide open, revealing large white teeth. The dark brown, almost black tail is made from real horsehair and retains some preserved flesh at the base.[4] The tail is approximately 31 inches in length. The hair is mounted on a curved wooden post that can be inserted and removed from the body of the horse. When the tail was removed during examination, a rodent nest made from cotton and wood chips was discovered in the hollow of the horse's belly. Copper wire wool were previously inserted in the hole surrounding the metal pole as a preventive measure against further infestation.

The horse has an English saddle, girth, rump harness, and overcheck carved in relief. The saddle appears to be painted orange with red and yellow lines, both of which are an 1/8 inch in width, and a thicker ½ inch dark blue line around the exterior edge. There is a painted motif at the front of the saddle, which unfortunately is mostly gone and is difficult to read. The girth, which is 3 inches in width, appears to be an orange pink with an 1/8 inch yellow stripe in the center and two dark blue ½ inch stripes along the outer edges. The blue-green rump harness is 3 inches in width and has two 1/8 inch yellow stripes on either side of a ½ inch dark blue stripe. The blue-

1 Richard Kerschner and Nancie Ravenel, "Here We Go 'Round Again: Cleaning Linseed Oil from Carousel Animals at the Shelburne Museum," *JAIC*, Vol 45(2006), 202-203.

2 Animals in each group of three are arranged hierarchically with the biggest, most ornate animal on the outside, and the plainest, smallest animal on the inside.

3 Wood was often basswood, pine, or poplar according to Frederick Fried, "Last Ride for Carousel Figures?" *Historic Preservation*, Vol 29, No 3 (July/Sept 1977), 25.

4 This detail is hidden from sight when the tail is secured in place.

green overcheck is 2 inches in width and has a ¼ inch dark black stripe surrounded by two 1/8 inch yellow stripes. The stirrups and reins are authentically constructed out of leather and metal. They are attached to the horse with metal staples. The stirrup on the plain, proper left side is 6 inches shorter than the one on the proper right. The horse has a dark red saddle blanket carved in relief with a 1/8 inch yellow line and a thicker 1/4 inch red line painted along the outer edge. The blanket has subtle folds modeled along the bottom edge. Another strap runs around the front and rear of the horse. This blue-green strap has a dark ½ inch black line along the top edge with two 1/8 inch yellow lines painted below. It has a 2 ¼ inch carved red ruffle attached to the bottom edge.

Some areas appear to have been repainted at some point in time. The overpaint is evenly applied and may have occurred at the Dentzel Factory in Philadelphia. Individual animals were occasionally sent back to the factory so that they could be updated to be more in mode with contemporary fashion. For example, early carousels were characterized by static, standing animals with all four feet planted firmly on the ground. Tastes changed over time to favor more dynamic poses and many animals had their legs altered so that one or more feet were in the air. This particular horse has both front legs off the ground as if it is leaping over an obstacle. Some painted areas along the edge of the dark red saddle blanket are abraded and reveal the presence of a blue-green paint. Abraded areas on the painted orange girth reveal the presence of a light blue paint.[5]

The romance side of the horse is fancier than the plain side. The romance side has more elaborate carving on the red ruffle, subtle folds in the saddle blanket, and is embellished with five glass bezels within brass settings. These bezels are attached to the blue strap running around the front and rear of the horse with varying numbers of small brass tacks. On the second bezel from the rear, part of the lower yellow painted line extends onto the brass.

CONDITION

Structure

The wooden components of the object are structurally stable. The metal and glass components are also structurally stable. The wooden body has small nicks and dents throughout as the result of use, especially on the saddle and areas surrounding the stirrups and bit hooks where the metal components rubbed against the wood. A small portion of the proper left ear is missing. This loss does not appear to be recent as the exposed wood is dark and covered with a layer of linseed oil. Some of the joints are slightly separated, which has caused the paint to crack along the join. Some dirt and linseed oil has accumulated in the crack.

The leather reins and stirrup straps are cracked, dry, embrittled, and stiff. They have white mold growth throughout. The proper left rein is torn 1 inch below the circular metal bit ring. The leather is creased from being tucked into the ring as a temporary aesthetic repair measure.

5 In 2005, conservator Melanie Brussat treated a Dentzel horse from the same carousel that had similar evidence of repainting (Conservation # 05-5-2212). She noted that several of the fleur-de-lis saddle flaps had paint losses that revealed the presence of a vermilion-colored underlayer. Brussat took a cross section from a painted black incised line on the saddle pad which revealed an initial layer of identical vermilion-colored paint. Brussat concluded that some or all of the incised lines were first painted with vermilion, and then later painted black. The red rump strap on the romance side has evidence of an initial yellow paint layer in the cross section, which Brussat notes matches the present color of the strap on the plain side. Furthermore, a loss in the pink paint of the proper right nostril reveals a much brighter red below, which further supports the repainting theory. A number of other cross sections reveal a layer of overpaint, a white preparation layer, and a varnish layer atop a lower layer of paint. Brussat cites the brown of the martingale where the jewel was removed on the plain side and the black incised line of the saddle pad as examples of this phenomenon. Brussat suggests that the overpaint was probably done in the Dentzel factory due to its neat, thin application.

Ground layer
There is evidence of a white ground layer in some areas where the painted image material is gone. This layer is visible along the edges of the rump strap, saddle and saddle blanket, front chest strap, and red ruffles, as well as on the mane and around the nostrils.

Paint layer
Overall, the paint layers are stable and appear to be in fair condition. No paint is actively flaking and the object can be safely handled or moved. There are minor scratches and abrasions throughout the surface as the result of use. Wear is especially evident on the saddle seat where the paint layer is almost entirely gone, edges of the saddle blanket, and areas surrounding the stirrups and bit hooks. Damages are more severe on the romantic side than on the plain side.

A number of scratches and abrasions stand out as more recent occurrences. There is a scratch approximately 1 inch long on romantic side of the saddle, adjacent to the left side of the stirrup strap. There is also a 1 ½ inch scratch towards the middle of the red saddle blanket on the plain side and an irregular circular shaped abrasion on the upper portion of the proper left back leg. Other newer abrasions are located on the back of the proper right leg near the knee joint, and around the proper right nostril.

A bright white accretion is present on the red ruffle near the front of the plain side.

Surface coatings
The object is covered with numerous applications of linseed oil, which have darkened considerably over time, obscuring the visibility of the original surface. Streaks and large drips of linseed oil create an uneven appearance, particularly on the legs, underbelly, face, and neck. In some of these more concentrated areas, the oil remains tacky. As a result, horsehair from the tail and dust has accumulated on the surface. There is dark mold growth evident on the paint along the edge of the saddle blanket and red ruffles, and on the underbelly.

Other materials, ornaments
The iron rings, buckles, staples, and stirrups are stable, but have evidence of minimal corrosion. In some areas, there is linseed oil splattered on the metal.

The glass jewels and eyes appear to be in good condition. Some of the jewels have small, brown linseed oil droplets on the surface. The second glass jewel from the rear has some minor scuffing. The metal leaf backing on all of the clear glass jewels is soiled and degraded. The brass setting elements are in fair condition. They are tarnished and darkened from repeated applications of linseed oil. There is a build up of oil in the crevices between the jewel and the brass, and between the brass and the wood. On the rearmost fastener, there is a pinkish substance that extends onto the adjacent paint surface.

The horsehair tail is brittle and unstable. Strands of hair are actively becoming detached. When the tail was removed from the body, a piece of cotton twill tape was used to hold the hair in place. There are some insect carcasses and nests present inside the tail.

TREATMENT PROPOSAL

1. Write condition report and treatment proposal.
2. Carry out pre-treatment photographic documentation and perform additional photographic documentation during treatment

3.
4.
5.
6.
7. Perform cleaning tests to determine the most effective methods for treatment. Previous documented
8. cleaning methods will be used to inform treatment. Aqueous based systems such as Pemulen and
9. Carbopol gels will be considered
10.
11.
12. Reduce maintenance linseed oil coatings and varnish layer using the developed cleaning system
13.
14. Remove the tail from the body. Vacuum and wash tail. Possible conditioning treatments will be
15.
16.
17. Clean brass fittings around the jewels. Fittings will not be removed for this portion of the treatment. The figure and glass jewels will be masked for protection during cleaning.
18.
19. Clean glass jewels in situ
20.
21.

22.
23. .Apply a new varnish
24. .
25. In-paint areas of loss or abrasion as necessary after consultation with Associate Curator, Kory Rogers.
26.
27. Write treatment report. Carry out post-treatment photographic documentation.

TREATMENT REPORT

1. Began written and photographic treatment documentation.
2. Vacuumed dust from surface using a soft bristle brush and a Miele *Black Diamond* vacuum with a brush attachment.
3. Removed tail from rear of horse in order to protect it from the solvents and gels used for linseed oil reduction. Wrapped the base of the tail with a piece of black cotton twill tape to reduce the risk of further hair loss. Vacuumed dust and insect carcasses from the tail using a Miele *Black Diamond* vacuum with various small nozzle attachments. Used tweezers and a wooden skewer to aid in insect removal and to detangle the tail hair. Used a Dahlia Spray mister with deionized water to wet small sections of the tail. White paper towels were used to absorb the water.[6] The dermis and wooden pole were masked with a piece of mylar for protection during the misting process. The base of the tail was reinserted into the body after varnishing.
4. Took three representative cross sections, one from an area of abrasion on the PR side of the saddle, one from a seam where two pieces of wood meet on the PR saddle blanket, and one from another wood seam on the PR side of the neck. Used an Optivisor and scalpel to obtain the samples. Samples were set into small ½ inch cubes of Bi-pax Tra-bond BA-F113 Lot #6311 brand epoxy. A detailed discussion of the cross sections is included in the Appendix.

6 Using white paper towels made it easier to monitor the effectiveness of the misting cleaning method. The water picked up a small amount of grime and dirt from the tail.

5. Performed solvent tests on the PL front leg to determine an effective method for linseed oil removal. Previous treatment and examination reports for other animals in the carousel were used to inform testing.[7] Testing results are listed in Appendix Table 1.
6. Reduced linseed oil coating overall using methods found to be effective through testing. Primarily used variations on an aqueous-based Pemulen gel with no added solvent, specifically a Pemulen gel with TEA and a Pemulen gel with TEA and Tris. These gels were applied to the surface with a soft bristle brush and removed with a dry cotton swab. The gel was cleared from the surface first with a solution of deionized water and TEA buffered to a pH of around 8 with citric acid, and then with deionized water alone. The effectiveness of each Pemulen gel depended on temperature and relative humidity in the lab, the painted surface on the horse, the thickness of the linseed oil, and the constituents of the gel. The horse was removed from the pole during cleaning so that the underbelly could be more easily accessed.
7. In areas where the linseed oil coating was thicker, such as underneath the front legs, large oil drips remained after the initial overall reduction with the Pemulen gels. These thick drips were reduced using locally applied solvent on a small swab and a scalpel.[8] Solvent tests were performed to determine the most effective combination. Testing results are listed in Appendix Table 2. Acetone alone and a 1:1 solution of acetone : isopropanol were primarily used. The solvents and the Pemulen gel with TEA and Tris were also used to reduce the deposits of linseed oil and grime in the joins where the tack meets the body and between the teeth.
8. Polished the five brass fittings in situ. Painters tape was used to mask the glass jewel and surrounding paint surface during polishing. Used a 5% DPTA solution in DI H_2O on a small swab to facilitate removal of corrosion and linseed oil splatters from the brass. Cleared DPTA with water. Used acetone to remove residual corrosion and oil. Polished brass with Autosol, a proprietary polish used in the automotive industry for fine polishing. Cleared Autosol from surface with benzine. Brasses were not completely polished, rather some tarnish was left around the tacks and in the crevices.[9]
9. Cleaned glass jewels and glass eyes with Acetone on a small swab.
10. Cleaned iron stirrups with mineral spirits followed by acetone. Polished stirrups with Butchers Boston Polish, Amber Paste Wax. The leather components of the stirrup were masked during polishing with a piece of mylar. It was not possible to polish the bit rings without leaving wax residue on the attached leather strap.
11. Vacuumed leather components using a stiff bristle brush and a Miele *Black Diamond* vacuum with a brush attachment. Flattened the distorted leather located near the upper proper left side of the rein using locally applied moisture and weights.[10] Mended the torn leather using BEVA371 film and strips of Reemay toned with Golden Acrylic paint to match the color of the leather. Cut holes in the Reemay so

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7 Previous methods of linseed oil reduction have varied widely. For the giraffe cleaned in 2004 (Conservation # 04-13-2146), the modular cleaning system, developed by Chris Stavroudis with the support of Richard Wolbers, was used. In 2006, Tody Cezar used Carbopol gel with TEA and citric acid buffered to a pH of 7.5, and a Carbopol gel with Ethanol and Ethomeen C-25 (Conservation # 06-05-2376). In 2007, Kim Crozier used an aqueous gel of Carbopol with TEA and citric acid buffered to a pH range of 7.5 – 8 (Conservation # 07-05-2411). In August of 2007, Wolbers visited Shelburne Museum as an advisor on an IMLS-funded project on the Dentzel Carousel. He recommended the use of two gelling agents, Vanzan and Pemulen TR2. Both have the advantage over Carbopol in that they are able to emulsify solvents and keep them in suspension. In December 2007, Laura Brill was the first to use a combination of Pemulen TR2 gel with benzyl alcohol, Pemulen TR2 gel with TEA and Tris, and Carbopol gel with TEA and citric acid (Conservation # 07-05-2426).

8 It was not possible further reduce the drips using gels without risk of over cleaning the surrounding paint. Solvent was wicked out of the swab onto a dry blotter in order to control the amount coming in contact with the paint. By using a small swab with a controlled amount of acetone, it was possible to minimize blanching.

9 Selective polishing allows the after treatment appearance of the brasses to better harmonize with the condition of the body paint and other attached elements in addition to matching the appearance of the polished brasses on other treated animals in the Dentzel carousel.

10 A solution of 10% ethanol in deionized water was used instead of deionized water alone in order to discourage mold growth. Remay, a non-woven polyester fabric, was used as an interface between the damp blotter and the leather during humidification.

that the small round metal fasteners on the reign would remain visible. Used a tacking iron to activate the BEVA371 and adhere the toned Reemay to the leather.

12. Removed rodent nest from the horse's belly using long-handled tweezers and a Miele *Black Diamond* vacuum with a variety of hose attachments. The interior cavity was examined using an endoscope after the nest was removed. The endoscope revealed the cavity to be irregularly shaped due to the numerous pieces of wood comprising the body.
13. Used two brushes[11] to apply a mixture of 3:1 – satin : glossy Golden MSA varnish with ultraviolet light stabilizers (UVLS).[12] The mixture was diluted with benzine to a workable viscosity (approximately 1 part benzine to 1 part varnish).
14.
15. Decided no inpainting was necessary after consultation with Associate Curator, Kory Rogers.
16. Carried out post-treatment written and photographic documentation.

MATERIALS

Recipes for solutions used for cleaning:

Pemulen gel – TEA
2 g Pemulen
200 mL Deionized water
20 mL TEA

Pemulen gel – TEA, Tris
2 g Pemulen
200 mL Deionized water
10 mL TEA
10mL 2% Tris in deionized water

Buffer solution
100 mL Deionized water
10 mL TEA
Buffered with 5 % citric acid in Deionized water to a pH 8

Purchased materials:

Acetone: J.T. Baker Inc., Phillipsburg, NJ 08665
Autosol Metal Polish: Solvolene Lubricant Limited, London, SE 8 England
Beva 371 Film: Conservator's Products Co., Chatham, NJ
Bipax: Tra-bond, BA-F113, Tra-con, National Starch and Chemical Company, 1-800-872-2661
Butchers Boston Polish, Amber Paste Wax: The Butcher Company, Marlborough, MA 01752
Citric Acid: Amend Drug & Chemical Co., Irvington, NJ 07111
Dissolvine D-40 (DPTA (5Na): Akzo Nobel Functional Chemicals, Lima OH 45804
Golden Acrylics, Blick Art Materials, Galesburg, IL 61402-1267

11 One “wet” brush was used to apply the varnish and a second “dry” brush was used to minimize drips.
12 The glass eyes, glass bezels, iron bit rings, and stirrups were masked with painters tape and plastic bubble wrap during varnishing. Golden MSA varnish was chosen over Soluvar, which was used for previous carousel animal treatments, because of the ultraviolet light filtering component.

Golden MSA (Mineral Spirit Acrylic) Varnish with UVLS (Satin and Glossy): Blick Art Materials, Galesburg, IL 61402-1267
Pemulen®TR 2: Protameen Chemicals, Totowa, NJ 07511
Reemay: University Products, Holyoke, MA, 01040
Triethanolamine: Fisher Scientific, Fairlawn, NJ
Tris(hydroxymethyl)amino methane: Sigma-Aldrich, St. Louis, MO 63103
Twill Tape: Talas, NY10011
U.S.P. Sterile Absorbent Cotton: Moore Medical Corp, New Britain, CT 06050

Total treatment time: 28 days (6 ½ weeks)

Conservator's Signature: _____ Date: _____

Approved by:
Director, Preservation & Conservation: _____ Date: _____

Curator: _____ Date: _____

Table 1 – Solvent Testing for Overall Linseed Oil Reduction

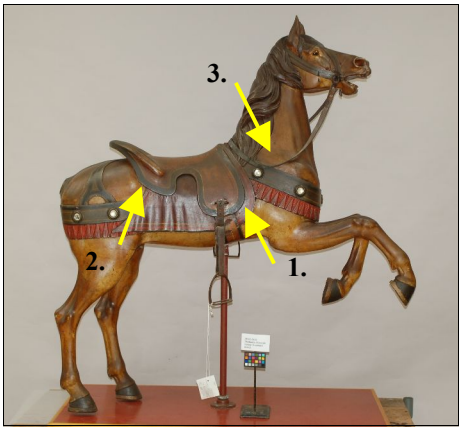
Paint Color in Area Tested	Solvent / Gel / Emulsion Used	Notes
White and tan body	Deionized Water (pH 6)	Swab turned slightly brown, no perceptible impact on linseed oil coating.
	Ethanol	Linseed oil is very soluble in ethanol, test successfully revealed a white paint layer. Works quickly.
	Acetone	Revealed 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 2% Tris in deionized water	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.

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.

Sample obtained by Objects Conservator, Nancie Ravenel from an area of paint abrasion on the underbelly tack strap
Sample obtained by Lauren Bradley from the edge of a wood join seam on the saddle blanket
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 – from an area of abrasion on the underbelly tack strap
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.[13] 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.[14] The uppermost layer in the sample

13 A suggestion put forth by Objects Conservator Nancie Ravenel.
14 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.

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 – from a seam on the saddle blanket
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 – from a seam on the proper right side of the neck
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.

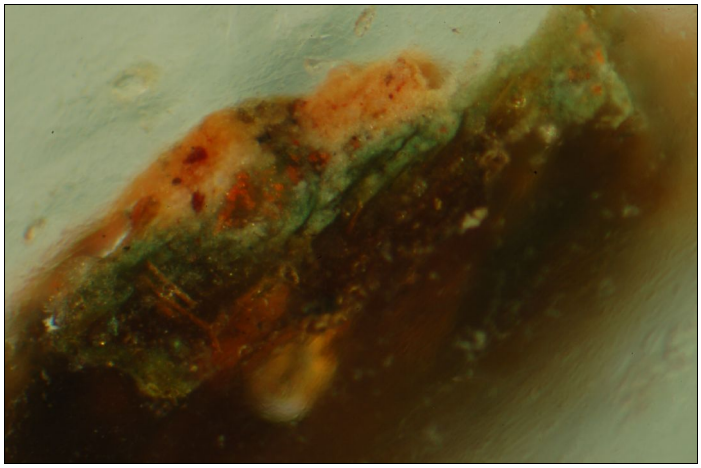
The dark grime-like layer could be indicative of overpainting. This conclusion, however, does not make sense when considering the color of the layers surrounding the grime – a bluish layer coated with a series of brown and white layers. Dentzel carousel animals were realistically rendered and painted, 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.

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.[15] The presence of a second primer coat, a white layer atop the green layer, however, is not addressed in this analysis.

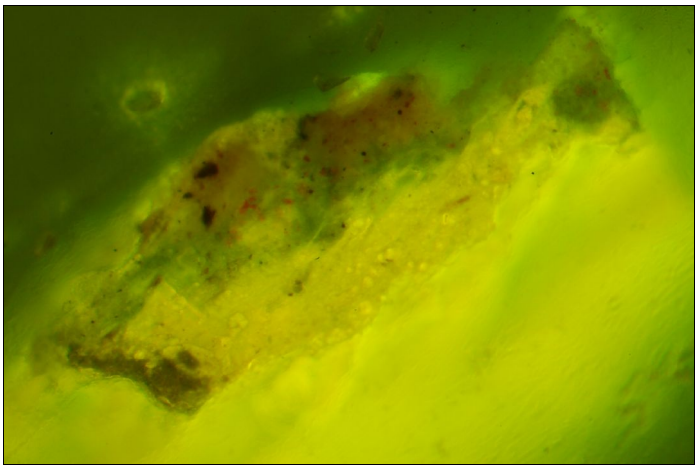
I expected to find two distinct layers of colored paint in Sample 2: the red color visible on the surface and the darker, blue-green color revealed in areas of abrasion along the edge of the ruffle. When considering the stratigraphy found in Sample 1, it is possible that Sample 2 may have yielded a similar 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.

15 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.

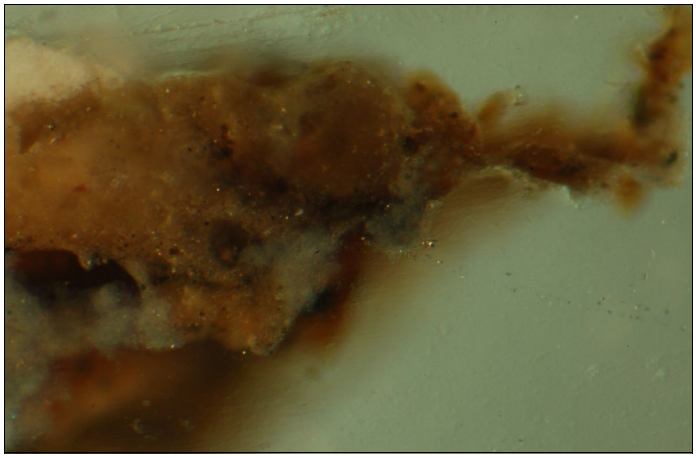
Cross Section Photographs



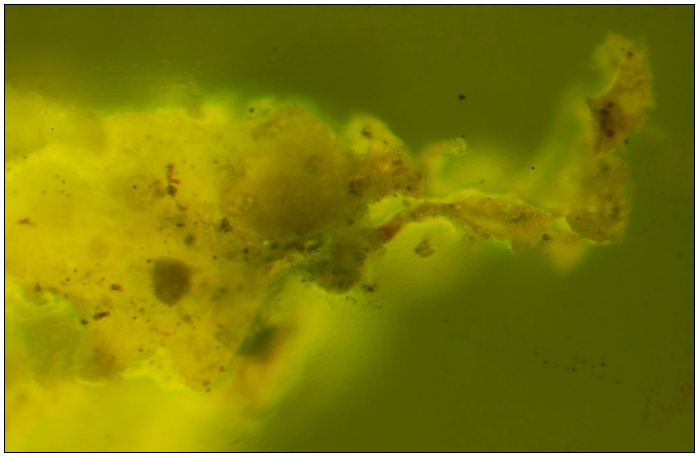
Sample 1 in normal light, 10x magnification



Sample 1 in ultraviolet light, 10x magnification



Sample 3 in normal light, 10x magnification



Sample 3 in ultraviolet light, 10x magnification