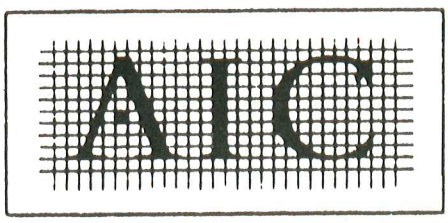
1994

AIC PAINTINGS SPECIALTY GROUP

POSTPRINTS



THE AMERICAN INSTITUTE FOR CONSERVATION
OF HISTORIC AND ARTISTIC WORKS

The American Institute for Conservation
of Historic and Artistic Works
1717 K Street, N.W., Suite 301
Washington, D. C. 20006

'THE BIGLIN BROTHERS TURNING THE STAKE-BOAT' BY THOMAS EAKINS: A TECHNICAL STUDY REVEALS SURPRISING TECHNIQUES

Christina Currie* and James Smith**

Thomas Eakins' great masterpiece of 1873, *The Biglin Brothers Turning the Stake-Boat* is the largest and most ambitious of his 1870's rowing series. The technical study revealed that the painting was the result of extraordinarily obsessive planning and attention to detail. From this investigation I have selected two topics for discussion, the first my own visual observations, the second, cross-sectional analysis carried out in collaboration with James Smith, senior microscopist at Cleveland State University/ NASA Lewis Research Center in Cleveland, Ohio.

PREPARATORY MARKINGS PRIOR TO PAINT APPLICATION

When I began to examine this painting closely with the stereo-binocular microscope, a complex pattern of tiny markings started to emerge. These included incised lines, incised compass arcs and tiny dark prick marks. To make sense of these observations, I laid a sheet of mylar over the painting, traced the outlines of the painted forms in black and traced all the incised markings in red.

Prior to painting the figures of John and Barney Biglin, Eakins indicated the main contours with minute prick marks. These appear slightly dark under the microscope today. Where they are completely masked by overlying paint x-radiography is the only way to visualize them. An extra line of prick marks in the water area adjacent to the right arm of John Biglin indicates that Eakins corrected the position of this arm during the registration process. This adjustment was probably made by shifting the position of an overlying sheet of transfer paper. There is a vertical carbon-based line starting at the bottom of Barney Biglin's hand and extending to the lower edge of the canvas. This is placed exactly in the center of the painting and is only visible in infra-red. In thinly painted landscapes by Eakins (for example *The Meadows, Gloucester, New Jersey* c 1882, Philadelphia Museum of Art), a central vertical line is often visible with the naked eye in what appears to be graphite.

To prove that the tiny prick marks were made before the paint layer was applied rather than after, I looked to the x-radiograph for evidence. On the computer, I annotated an scanned image of an enlarged x-radiograph of the head of John Biglin, locating the prick marks in yellow. On a scale of 1:1 with the painting, the prick marks on the x-radiograph measure only 0.2 mm in diameter and appear as regular tiny black dots. I noted a number of additional prick marks in the x-radiograph that are totally hidden under original paint proving that these markings were indeed part of Eakins' preparatory process.

Eakins marked the positions of the small but important upper left and right boats with narrow, ruled, horizontal, incised lines. These are crossed by incised compass-drawn arcs in pertinent places. As with the prick marks, these precise incisions are also only visible with the aid of a microscope or with an enlarged print of an x-radiograph and are often partially filled or concealed by paint. They are sharp in character and obviously made into a dry ground layer. Incised lines border the right tip of the upper right boat. Compass arcs and incised horizontal and vertical lines are used to delimit the splash of the lower right oar as it hits the water.

In addition to incised lines and dots, underdrawing was visible with the microscope and infra-red reflectography. A dry drawing material, probably graphite, was found on certain contours of the Biglin's boat. For the lines visible only in infra-red I found it impossible to tell whether they were applied with wet or dry mediums. Outlines follow all the major contours of the Biglin's boat including its lower shadow in the water. The

---

*Christina Currie is currently practising as a Paintings Conservator in Brussels, Belgium. She was formerly a Fellow in Painting Conservation at The Cleveland Museum of Art, supported by grants from The National Endowment for the Arts and the Andrew W. Mellon Foundation.
**James W. Smith is Senior Electron Microscopist at Cleveland State University/NASA Lewis Research Center.

uppermost tip of the stern is located along a ruled diagonal line drawn from the right edge of the painting to approximately the center of the right side of the boat. Fine lines also denote most of the profile and contours of the two men. Scattered hand-drawn notations are also apparent in places in the water to indicate highlights. Loose, slightly imprecise underdrawing locates the red-capped figures in the upper right.

With the naked eye it is possible to distinguish large conical pinpricks along the top, bottom and sides of the painting at approximately one inch intervals. They are probably large pinholes resulting from the adherence of transfer paper, either by Eakins, for his lost full-scale watercolor of the painting or by his pupil Alice Barber, who made an engraving after it.

The Biglin Brothers Turning the Stake-Boat, being by far the largest and most ambitious of the rowing series might well have merited unusually detailed preparation. I therefore examined other rowing and boating scenes by the artist during this period in his career. Through microscopic examination, I found that the markings on *The Biglin Brothers turning the Stake-Boat* are by no means unique. In fact, almost every boating scene in oil that I examined showed some form of incised marking as well as drawing lines made in dry and wet mediums.

One example is the Metropolitan Museum of Art's *Max Schmitt in a Single Scull*, painted in 1871. Here, in the bridges, lines of prick marks outline the rounded forms, and incised lines follow the straight elements . In the water area incised diagonal perspective guidelines locate Max Schmitt's boat. Important points near or along these guidelines are marked with pairs of incised arcs. In two places, the ends of incised lines are marked by tiny red arcs that are not incised. The position of the small upper left boat is marked with horizontal incised lines. Incised lines are also found under the contours of Max Schmitt's boat and oars and under the ripples behind it. In places a drawing material, probably graphite, possibly strengthened with a ruling pen or brush, could be discerned underneath the paint of his boat and oar. While incised prick marks around the figure of Max Schmitt were not distinguishable, this does not preclude their presence.

A similar range of incised lines, dots and drawing lines were noted on the Philadelphia Museum of Art's *Pair-Oared Shell* of 1872, *Biglin Brothers Racing* of around 1873 at the National Gallery of Art and *The Schreiber Brothers* of 1874 at Yale University Art Gallery.

PREPARATORY DRAWINGS

There are only two known extant preparatory drawings for *The Biglin Brothers Turning the Stake-Boat*, a small-scale drawing in the collection of The Cleveland Museum of Art and a scaled perspective drawing of the boat in the Hirshhorn Museum. The small-scale drawing is compositionally the same as the final painting but there are small differences in the figures. The reverse has been shaded for transfer. When my tracing of the final painting to the Hirshhorn was laid on top of the scaled perspective drawing of the boat, I noted no changes. This indicates that Eakins worked out the design and precise details of the boat to scale prior to transferring it to canvas.

Eakins concern for precision is illustrated by the following quote from his unpublished manuscript on drawing of around 1884, held in the Philadelphia Museum of Art, 'To measure small parts of an inch you should have a diagonal scale, or make one on paper by dividing an inch in 10 equal parts, drawing lines at right angles through these divisions and marking off 10 divisions on these last lines. Diagonals then drawn from the tenths on the top line to the next tenths on the last line will in traversing the whole distance gain the one tenth by regular stages of tenths of hundredths. You can thus accurately measure hundredths of an inch with your compasses, and estimated between the tenths across the scale you can estimate very closely to the thousandths of an inch.'

We know that there were more drawings for *The Biglin Brothers Turning the Stake-Boat*, based on a letter from Eakins' pupil Charles Bregler to The Cleveland Museum of Art in 1942. Bregler relates that 'Eakins made accurate drawings of the ground plan of the boat etc. But it was impossible to save them, the paper being in a state of decay.'

It is also likely that Eakins made loose, out-of-doors oil studies for this painting to establish tone and color; such studies were probably discarded or painted over. It is probable he made at least one detailed figure study for *The Biglin Brothers Turning the Stake-Boat*, either in oil or pencil or both, followed by a perspective

drawing to include the figures, as in the preparatory drawing of *John Biglin in a Single Scull* (Museum of Fine Arts, Boston), which was a study for a watercolor of 1873.

Eakins' manuscript provides clues to his method of transferring his designs to canvas but there are no explicit instructions. At one point he describes a complicated squaring-up method of transferring information from a ground plan to a perspective plan. Later on in his career, Eakins squared-up his rough oil studies and a set of corresponding squares in pencil can often be found in the final painting. In the rowing and boating canvases there are no such signs of squaring-up. Based on his writings and my observations, I think that Eakins' first mark on the canvas would probably have been the drawing of the exact vertical and horizontal centers. Next, he most likely transferred the important points of the boats from a scaled drawing to the canvas using dividers, protractor and compasses, perhaps with the set of drafting tools in the collection of the Hirshhorn museum. I think he would have transferred the figures by tracing them onto transfer paper from a detailed preliminary drawing or printed illustration of some kind and pricking through the tracing to the primed canvas with a sharp point. Later he probably joined up the dots with a drawing material and strengthened the outlines with a ruling pen or thin brush.

PAINT LAYERS

Within *The Biglin Brothers Turning the Stake-Boat,* there is a strange marriage between the delicate, almost watercolor technique in the lower half of the painting and the thick, more spontaneous paint work of the riverbank and sky. X-radiographic details illustrate the contrast sharply. In the thinly painted lower half of the painting Eakins carefully abuts his different paint areas, which explains the black outlines around the figures in the x-radiograph. In the sky, the palette knife is used to create a dense and textured surface.

Not surprisingly, the thick paint layer in the sky is marked by drying cracks. Eakins first painted the sky light blue with a thick bristle brush and then covered it with a ochreous/creamy color applied with a palette knife. Above this is a thin, broken, semi-transparent, ochreous layer which may or may not be original.

The lower central highlights in the water are not painted as such, but are reserved sections of ground, as in watercolor painting. In these highlight areas one can make out the light, pitted commercial ground surmounted by a brown/black imprimatura or toning layer. The pits appear to be burst air bubbles. The glaze-like toning layer was also noted in cross-sections of the sky. Where the pitted ground is left visible by Eakins to form in the lighter parts of the scull, this toning layer was not present. Presumably Eakins avoided toning this area in order to preserve luminosity. In *Max Schmitt in a Single Scull*, which is painted on a similarly pitted commercial ground, I observed a deep blue rather than a brown/black imprimatura. As in the Cleveland painting, this layer does not appear to be present underneath the main scull.

Other painterly techniques in *The Biglin Brothers Turning the Stake-Boat* include glazing, toning, reworking over wet paint, rubbing with a solvent-soaked cloth or brush to create thinness and using the back of the brush through wet paint to break up reflections.

CROSS-SECTIONAL ANALYSIS

I selected a cross-sectional sample from the lower left sky for this paper, shown in accompanying figure. The questions I set out to answer are as follows:

1) what is responsible for the sparkly fluorescence under an ultraviolet light source in layers three and six?[1] Could it be zinc oxide, which is known to cause this phenomena under certain ultraviolet excitation conditions?
2) what are the transparent lumps in layer three, which fluoresce under ultraviolet excitation? (filter set as above) - could they indicate resin in the media?
3) what is upper semi-transparent toning layer and is it authentic? I have observed this type of layer, usually partially removed by cleaning, on many landscapes by Eakins.
4) what is the general chemistry of the various layers?

[1] filter set: ultraviolet, wide transmission filter G365, chromatic beam splitter FT 395, barrier filter LP 420

James Smith carried out scanning electron microscopy on the cross-section at the NASA Lewis Research Center[2]. He performed elemental analyses on selected areas by energy dispersive and wavelength dispersive x-ray spectrometry. Both secondary electron and backscatter electron images were acquired on representative areas.

From his results I have selected the most relevant to my queries.
The backscatter image of the cross-section shows that the various paint layers, although quite similar under ordinary illumination, have vastly varying chemistry.

Various x-ray modulation scans, otherwise known as x-ray dot maps were carried out for different elements including oxygen, carbon, aluminum, silicon, phosphorus, sulfur, chlorine, calcium, potassium, iron, zinc and lead[3]. The density of white dots is proportional to the relative x-ray intensity for the element being scanned. Correlations between these maps can help to answer questions about pigment distribution.

Dot maps for zinc and lead distribution clearly show that lead rich layers alternate with zinc/lead rich bands. From the oxygen dot map, it was also clear that higher levels of oxygen correspond to higher levels of zinc, indicating zinc white. The zinc/lead rich bands correlate with the areas of green sparkling fluorescence observed with the microscope suggesting that such fluorescence is indeed attributable to significant quantities of zinc oxide. The ground layer is clearly lead-based with no zinc.

Why Eakins varied the proportions of zinc and lead in his paint layers is open to interpretation. It may have been fortuitous but he was probably aware of the differing aesthetic and mechanical properties of lead and zinc white, for example zinc white's high opacity but tendency to dry brittle and crack versus lead white's advantageous drying properties[4].

---

[2]After dry-polishing with Micromesh^{R} 12.000, the cross-section was coated with approximately 200 angstroms of evaporated carbon. The investigation was performed on a JEOL 840-A electron microscope used by the Analytical Science Branch of the Materials and Structures Division at NASA Lewis Research Center. Simultaneous with the SEM examination , elemental analyses were performed on selected areas of the section by energy dispersive x-ray spectrometry (EDX) and wavelength dispersive x-ray spectrometry (WDX). The EDX system used is the Kevex Delta V with a Quantum^{R} thin window detector. EDX detects the presence of all elements in a selected area with atomic numbers greater than 11 (sodium) and in concentrations greater than a few tenths of one-percent. Carbon, oxygen and nitrogen are also detected if present in quantities greater than approximately 4-5 weight percent. The WDX system consists of a Microspec WDX-3PC equipped with a four crystal fully focusing spectrometer which covers the wavelength range for all elements with atomic numbers greater than 5 (boron). Characteristic x-ray lines were detected individually and the sensitivity was typically in the ppm range (0.001 wt%=10ppm). There was no attempt to quantify the EDX or WDX data due to the fine size of most pigment particles encountered (1.0μm or less). Individual EDX spectra were all collected at 15kv-600pA probe current. Both secondary electron and backscatter electron images were acquired from representative regions of the cross-section. EDX qualitative spectra were acquired from the individual layers to determine general compositions. Counts were obtained for 100 sec. at 600 pA from regions approximately 10 x 10μm.
[3]The optimum accelerating voltage for each spectral line was a compromise to reduce the adverse effects of spatial resolution losses, absorption effects, and to minimize electron beam damage. Typically, the maximum probe current was 12 nA.
[4]I am grateful to Dr. Leslie Carlyle for sending me the relevant passages of her thesis which may explain Eakins' layering of lead white layers with mixtures of lead and zinc white. During the latter part of the nineteenth century, writers on art were worried about the possible chemical changes caused by hydrogen sulphide on lead white. Various solutions were proposed such as mixing the lead white with zinc white or layering lead white layers with zinc white layers. Most of these publications appeared after *The Biglin Brothers Turning the Stake-Boat* was painted. However, the concern was known before and Eakins may well have shared it. Windsor and Newton's 'New White' appeared in their catalogue for 1849 which was a mixture of white lead and zinc white. Fuller information available in Dr. Carlyle's pH. D. thesis, Courtauld Institute of Art, University of London, submitted 1991, 'A Critical Analysis of Artists' Handbooks, Manuals and Treatises on Oil Painting Published in Britain Between 1800-1900: with reference to selected eighteenth century sources.'

For the ground layer, in addition to major lead white, there is iron in small proportions in the upper regions. One typical iron containing particle also contained aluminum and silicon suggesting the presence of an ochre or sienna pigment. In the imprimatura or toning layer there is calcium, phosphorus and oxygen suggestive of bone black. Iron and magnesium were also identified in a this layer indicating an umber pigment which would have acted as a drier. In layer three, the light blue layer, the regions of unpigmented medium are characterized only by large amounts of carbon. There are no lead or zinc particles in these areas. For layers four, five and six, the ochre-colored layers, the main constituents are lead carbonate mixed with many aluminosilicate type particles. These particles have an approximately 1:1 ratio of aluminum and silicon and might be china clay, a common filler. Quartz is a frequent impurity. In layer six, in addition to lead and zinc, there are several particles rich in silicon, aluminum, magnesium, potassium and minor iron suggestive of green earth. In this layer there are also many iron oxide particles, generally with minor amounts of aluminum and silicon suggesting an ochre or sienna pigment. Calcium carbonate particles were also detected. In the uppermost 'toning' layer, layer seven, in which there are no coarse particles, zinc, sulfur, chlorine and oxygen are present. A few particles of silicon dioxide were also noted as in other layers. Unfortunately, this result does not answer my question regarding the authenticity of this layer.

For medium analysis of the sky, a small sample of the lower light blue layer and a small sample of the upper ochre/creamy layer(s) were taken and analyzed by Fourier transform infra-red microspectrophotometry (FTIR). For the light blue layer, which contains fluorescing areas of pure medium in the cross-section, the spectra suggest the presence of a natural resin. For the upper ochre-creamy layer applied with a palette knife, the sample appears to contain a cross-linked oil, possibly linseed.

The evidence I have presented gives a fair idea of the wide range of drawing and painterly techniques used by Eakins to construct his rowing scenes. The drawings and preparatory material suggest Eakins the young but totally accomplished draftsman, a result of his rigorous training at Central High school in Philadelphia and with Gerome in Paris. The paint layers reveal Eakins as an inspired, experimental but as yet inexperienced painter.

ACKNOWLEDGMENTS

I would like to thank all those who have helped me in this project. In particular Marcia Steele and Kenneth Bé at The Cleveland Museum of Art. I am also very grateful to the conservation staff in other museums who allowed me to examine their paintings and took an active interest in my examinations. I would also like to thank the George Stout Fund, which supported my participation in the conference. This work will be published in more detail as an essay for the catalog of the 1995 exhibition of Thomas Eakins' sculling scenes organized by Helen Cooper, curator of American paintings at Yale University Art Gallery. The exhibition will travel to the National Gallery and The Cleveland Museum of Art.

Thomas Eakins, *The Biglin Brothers turning the Stake-Boat*
cross-section, lower left sky