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**Refining Style: Technical Investigation of an Early Work by Georges Pierre Seurat in the
Maurice Wertheim Collection**

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1. Abstract:

Throughout his artistic career, Georges Seurat devoted himself to the current color and aesthetic theories of his time. Early on, he began applying these theories to canvas, fine-tuning both his technique and selection of materials, culminating in his mature style, pointillism, around 1886, exemplified by *A Sunday Afternoon on the Island of La Grande Jatte*. This study investigates an early work by Seurat, *Vase of Flowers*, c. 1878 - c. 1879, in the Harvard Art Museum's Wertheim Collection, painted around the time he quit the École des Beaux-Arts in Paris in 1879. A number of recent studies (Kirby, Jo. et al. 2003; Herbert and Harris 2004) have characterized Seurat's later style, technique, and material choices; there is, however, a dearth of material about his earliest works.

The goal of this study is to gain a better understanding of Seurat's early technique and style, especially when compared to his later works. The primary scientific methods employed include examination with the stereomicroscope, ultra-violet radiation (UV), Infrared Reflectography (IRR), X-Radiography, cross-sectional analysis with Reflected Light Microscopy (RLM), Scanning Electron Microscopy Energy Dispersive Spectrometer (SEM-EDS), and Fourier Transform Infrared Microspectroscopy (FTIR).

2. Introduction:

The renowned Maurice Wertheim collection is one of Harvard Art Museums most notable groupings of impressionist and postimpressionist paintings, drawings and sculptures. This body of work was bequeathed to the Fogg Museum in 1950 by Maurice Wertheim, though with certain stipulations that made comprehensive technical examination and analysis of it difficult until the recent years. The terms of the donation required that the collection must remain as a single entity, be placed on permanent exhibition and always made available to Mrs. Wertheim until her death. In 1974 when Mrs. Wertheim passed, the collection went on continuous permanent view, with only a few works of art off view during a loan for three months at a time.

In 2007, the Wertheim collection was removed from exhibition when the renovation and expansion project to the Harvard Art Museums' Quincy Street location commenced. This offered the valuable opportunity to perform an in-depth technical study of the collection. While technical analysis on many of the artworks within the collection has already been conducted, there is little to no technical information on a small still life painting by Georges Pierre Seurat, *Vase of Flowers* (1974.100), c. 1878 - c. 1879 (see Figure 1).

Georges-Pierre Seurat is best known for his systematic and controlled artworks, associated largely with pointillism. He developed his techniques and divisionist style of painting over a little more than half a decade, devoting himself to the current color and aesthetic theories of his time. *Vase of Flowers*, painted around



Figure 1. *Vase of Flowers*, oil on canvas, c. 1878-79, 18 1/4 x 15 3/16 in., Harvard Art Museums, Massachusetts.

1878-1879, is an early work within Seurat's oeuvre and shows the groundwork of his technical development as an artist. The goal of this project is to gain a better understanding of Seurat's early technique and style and how *Vase of Flowers* is characteristic of this period in his artistic development, especially when comparing this painting to his later works.

There is little to no information published regarding the materials and methods of Seurat's earliest period, however, a number of Seurat's paintings, both sketches and finished works from his independent and later period were recently studied and analyzed by other institutions, including The Art Institute of Chicago and the National Gallery of Art, London. These studies provide a wealth of information that characterizes Seurat's later style, technique and material choices, providing comparative material for the study of *Vase of Flowers*.

The opportunity to study this painting by Seurat will provide valuable new data for an important part of Harvard Art Museums' collection. Historical research into Seurat's life and career as an artist will help guide the technical investigation of Seurat's techniques and materials. Analysis of the pigments and layering structure of *Vase of Flowers* will deepen the understanding and appreciation of the painting and shed light on his early development as an artist. In addition, this project will include a treatment component; aqueously cleaning dirt and grime that covers *Vase of Flowers* may lead to varnish removal or reduction.

3. Georges Pierre Seurat

3.1. Artistic Development

On December 2, 1859, Seurat was born in Paris into a bourgeois family and fortunate that his family supported his artistic inclination, allowing him to pursue art early in life. At the age of 16, in 1875, Seurat was enrolled at the École Municipale de Dessin et de Sculpture in Paris. Taught by Justin Lequien, he acquired the drawing skills needed to enter the prestigious École des Beaux-Arts by drawing from plaster casts and copying lithographs.¹ In 1878, Seurat was admitted to the École des Beaux-Arts in Paris and taught by the conservative academic painter Henri Lehman, a pupil of neo-classicist Jean-Auguste-Dominique Ingres (see Figures 3 and 4). In Lehman's atelier, Seurat followed the conventional academic practices, studying works by early Italian and 17th-century French artists in the Louvre, making studies of these works and drawing from the École's collection of plaster casts, paintings and sculptures.



Figure 2. Photograph of George-Pierre Seurat, French, 1859-1891.

Many drawings exist from this period of Seurat's academic years, 1876-1879, showing he was a fine draftsman and proficient at realistically portraying the human figure (see Figures 5 and 6). There are however, only five known paintings by Seurat that date to the same period, all of which seem to fall into

the category of painted sketch, rather than a finished work (see Figures 7 – 10). Two of these five paintings, *Angelica at the Rock (After Ingres)* (1878) and *Head of a Young Girl* (1877-1879), were executed using traditional technique, starting with a graphite sketch on a cream ground, followed by layered paint. The former, is a painted copy Seurat made of Ingres' *Roger Freeing Angelica*, while it hung in the Louvre (see Figure 11).



Figure 3 (left). *Portrait of Franz Liszt*, Henri Lehmann, 1839, P. Pierrain/Musee Carnavalet, Histoire de Paris, Paris.

Figure 4 (right). Group of Lehman's Students at the École des Beaux Arts. Seurat stands sixth from the left. Ex coll. Mlle Yolande Osbert.

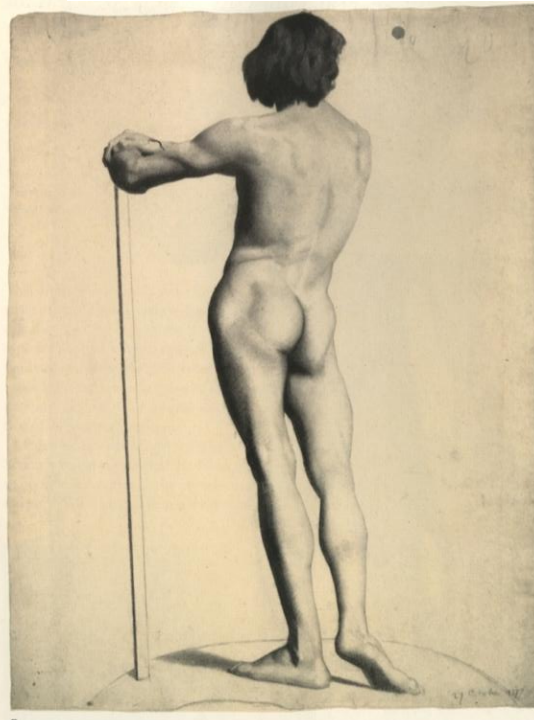


Figure 5 (left). *Angelica*, after Ingres, 1877-78
Figure 6 (right). *Back View of a Male Nude, Leaning on a Staff*, 1877.



Figure 7 (left). *Head of a Young Girl*, oil on canvas, c. 1877-1879, 12 x 9 7/8 in., Dumbarton Oaks Research Library and Collection, Washington D.C.

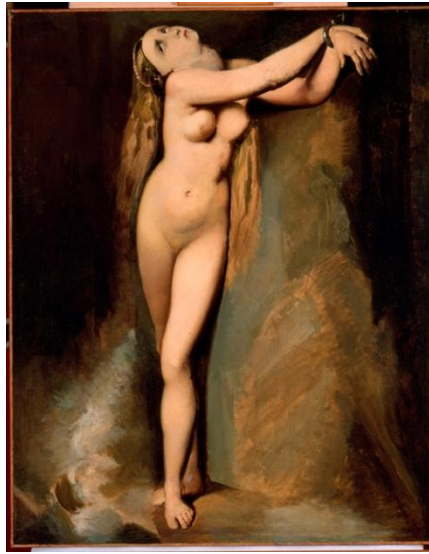


Figure 8 (right). *Angelica at the Rock (After Ingres)*, oil on canvas, 1878, 32 5/8 x 26 1/8 in., Norton Simon Museum of Art, California.



Figure 9 (left). *La Baigneuse au Rideau*, 1879, oil on board, 12 3/16 x 8 11/16 in., location unknown.



Figure 10 (right). *Jupiter et Thétis*, 1881, oil on board, 18 1/8 x 14 15/16 in., location unknown.



Figure 11. Jean-Auguste-Dominique Ingres, *Roger Freeing Angelica*, 1819, oil on canvas, 57 7/8 x 74 1/4 in., Musée de Louvre, Paris.

There is clear evidence of the fine preliminary drawing throughout *Angelica at the Rock (After Ingres)*, especially visible in the more thinly painted areas, such as the feet and toes. From examining high-resolution digital images and examination reports of the painting, the handling of the paint varies from thin washes of translucent oil paint to creamy opaque areas. The background, rocks and hair of the figure are more loosely suggested, painted in liquid, translucent paint that left exposed ground. Contrasting, is the figure of Angelica, which is more highly finished and controlled; painted in opaque passages with thoughtfully placed highlights, mid-tones and shadows. Some brushmarking is visible in the arms, fingers and forward leg.²

Head of a Young Girl, like the study of *Angelica at the Rock (After Ingres)*, also shows evidence of Seurat's academic training. Again, from examining high-resolution digital images and examination reports of the painting, Seurat used a cream colored smooth ground, upon which he then sketched out his composition in loose graphite. This is mainly visible at the neck and the clothing of the figure. There is a quality of spontaneity to the painting, clearly done with confidence, especially when capturing details such as the sitter's ear. The paint layer is thin though still opaque and the flesh tones, hair and eyebrows are worked wet-in-wet.³ Brushmarking is evident throughout, though there is no true impasto. There is a thin, quickly painted wash over the background, similar to the rocks in Seurat's study of *Angelica at the Rock (After Ingres)*. The collar and upper back of the figure in *Head of a Young Girl* were deliberately left unpainted; Seurat used the color of the ground as part of the composition.

There is very little information regarding two of the other early paintings *La Baigneuse au Rideau* and *Jupiter et Thétis*, including their current locations. Their classical subjects are those of the Beaux-Art tradition but even in the old reproductions of the paintings, it is clear that the brushwork is more broken and less blended than would be expected from a student in training. Aesthetically, *Vase of Flowers* is closer to these two mythological paintings than *Angelica at the Rock (After Ingres)* and *Head of a Young Girl*. In terms of its date, *Vase of Flowers* falls near the academic years, though the palette and technique clearly move away from the academic tradition as Seurat moved away from the use of line and traditional handling and modeling of paint.

Through Seurat's own diary and letters, there is evidence enough to recognize it was early in his academic career, while still enrolled in the École des Beaux-Arts, that he became unsatisfied with the academic approach to art. Although Seurat enrolled in Lehman's class in March 1878, he left shortly thereafter and rented a studio in the rue de l'Arbalete in the fifth arrondissement of Paris, which he shared with another former student of the École, Aman-Jean. At this time, Seurat began to work on his own, producing small-scale paintings and drawings. In an account from Aman-Jean's memoirs regarding this period and choice to leave the École, he wrote "When we left the École des Beaux-Arts, we took a studio, whose rent we shared as to work together and to try to find what stuff we were made of; to add, to complete, and to erase partly what was inane and so incomplete in the *Grammaire des art* taught at the École."⁴ In November 1879, Seurat joined the army for one year of compulsory service, after which he returned to drawing and painting, rejoining Aman-Jean in their studio. During this independent period, Seurat's focus shifted from the academic painters he studied at the École to the impressionists, Barbizon school and works of Eugène Delacroix. The paintings he produced from 1881-1884 were mainly natural scenes; landscapes often with peasant figures in the composition (see Figures 12 and 13).



Figure 12 (left). *Sunset*, oil on wood, c. 1881, 6 x 9 7/8 in., Bristol Museum and Art Gallery, Bristol.

Figure 13 (right). *Stone Breaker*, oil on canvas, c. 1882, Private Collection.

Working independently, Seurat refined his working process, fine-tuning both his technique and selection of materials. In 1883, Seurat submitted *Bathers at Asnières* to the jury of the Salon for public exhibition but was rejected (see Figure 14). In the summer of 1884, however, the painting was in the first exhibition of the Groupe des Artistes Indépendants, an organization of which Seurat was one of the founding members. Although *Bathers at Asnières* is considered Seurat's first major oil painting, he did not fully reach what is considered his mature style until 1886, best exemplified in *A Sunday on the Island of La Grande Jatte* (1884-1886), which he completed in May 1886 (see Figure 15).

Throughout Seurat's entire artistic career, his style and technique were constantly evolving. He continually sought new ways to improve his technique and implement what he described as an "optical formula." This evolution of his style is best exemplified when comparing the technique used in late works such as *Young Woman Powdering Herself* to *Vase of Flowers* and then paintings made slightly later in time, such as *A Sunday on the Island of La Grande Jatte* (see Figure 16). When comparing the technical aspects of these paintings, one can see Seurat's divisionist technique became even more polished and tightened with the application of individual small strokes of paint and subtly and thoughtfully constructed harmonies and contrasts of color.⁵

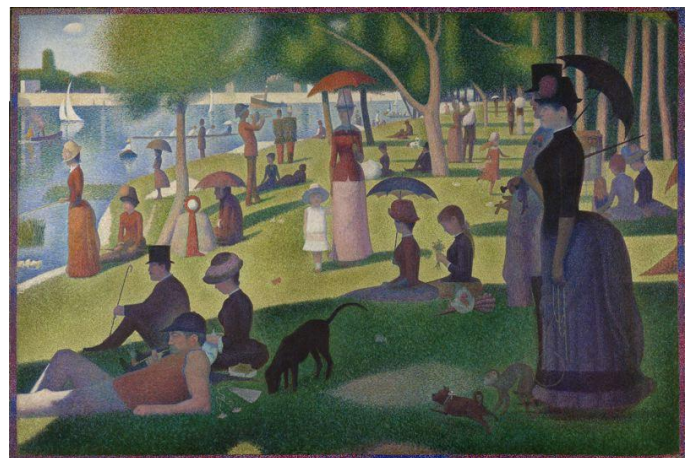


Figure 14 (left). *Bathers at Asnières*, oil on canvas, 1884, 79 1/8 x 118 1/8 in., National Gallery, London.

Figure 15 (right). *A Sunday on the Island of La Grande Jatte*, oil on canvas, 1884-86, 81 3/4 x 121 1/4 in., art institute of Chicago, Illinois.

3.2. Aesthetic and Scientific Influences

In 1890, Seurat wrote a letter to the art critic Félix Fénéon, to set the record straight that, he, Seurat, not Paul Signac, established the technique of optical painting (see Appendix 1). To prove his point, Seurat gave a precise account of the early theoretical readings and artistic interests that he pursued in search for an “optical formula.” Seurat pursued a way to apply valid laws of art, aesthetics and color theory to his own technique, literally applying these theories to canvas. In order to appreciate why Seurat used a specific color in a particular way, it is crucial to understand those whose work affects the creation of *Vase of Flowers*. These specific scientific and artistic influences include Eugène Delacroix, Charles Blanc, Michel-Eugène Chevreul and David Sutter.

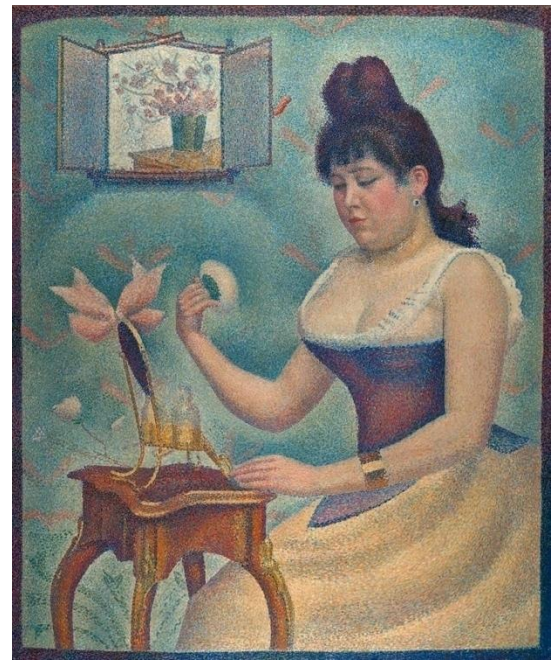


Figure 16. *Young Woman Powdering Herself*, 1890, oil on canvas, 37 1/2 x 31 1/4 in, Courtauld Institute of Art, London.

One of Seurat's earliest and major artistic influences was Eugène Delacroix. Throughout 1881, Seurat saw at least nine of Delacroix's paintings and wrote detailed accounts of each in his diary. These often focused on Delacroix's use and placement of colors throughout a composition, as well as describing technical aspects such as the color of the ground, underpainting and brush handling. In one particular account, he wrote vividly about the “*delicacy* of the orange-gray and blue-grey ground,”⁶ A point Seurat fixates on in his descriptions were the harmony and the relation that certain colors created when placed near one another, such as reds and greens. Regarding Delacroix's *Fanatics of Tangier* (see Figure 17), Seurat wrote:

In the foreground, red or rather orange man. Next to him on the right, young boy, dark blue clothing. The blue and the orange harmonize again in the man to the right of the fanatic who is falling back-wards. He is wearing a vivid orange garment in which there is a great deal of vermillion; this color is surrounded by the blue-grey fabrics in which the figures of the middleground are dressed.”⁷ (February 23, 1881)

Seurat's diary entries describe what he was most interested in at the time and remained interested in throughout this career, “the use of complementary hues to create coloristic harmony and more particularly, the way in which complementary colors can be used as agents of modeling, to modify and enliven neutral tones of grey.”⁸

Alongside his musings on the harmony of Delacroix's red and greens, Seurat became increasingly interested in the scientific and theoretical writings on color theory of his



Figure 17. Eugène Delacroix, *Fanatics of Tangier*, 1838, oil on canvas, Minneapolis Institute of Art.

time. Seurat's first acquaintance with color theory was before admission to the École, when he read Charles Blanc's *Grammar of Painting and Engraving* (1867). Blanc wrote extensively on art theory, Chevreul's book *Principles of Harmony and Contrast of Colors* (1855), and created objective laws of art based on the artworks of those he believed to be 'model artists.' Blanc extolled two contemporary artists of the day, praising Delacroix's use of color and Ingres' expression of form: 'It is the converse of M. Ingres, who creates his colour to fit his form; Delacroix creates his form to fit his colour.'⁹

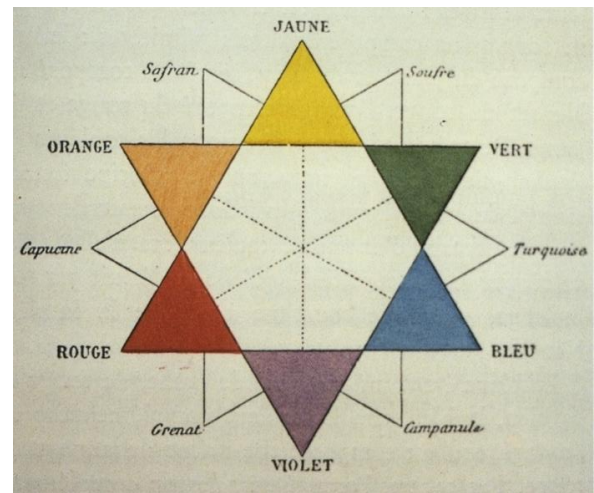


Figure 18. Blanc's *Rose Chromatique*, from *Grammar of Painting and Engraving*.

Blanc also believed chiaroscuro and color were equally important and that a progressive artistic training should move from line, via chiaroscuro, to color. This may explain why there are so many drawings by Seurat during his earliest period and so few paintings. Another influencing factor of Blanc's writings on Seurat, are his established rules for the formation of light and dark tones, in which he states "a painting should never have two bright or two dark masses of the same intensity. Half-tones should occupy about half of the surface; the other half should be parceled out into equal areas of light and dark."¹⁰

Furthermore, in Blanc's *Grammar of Painting and Engraving*, he describes that the way in which two colors are juxtaposed affects how those colors are perceived; when two complementary colors are placed alongside one another, the boundary that separates them produces the most striking optical mixture.¹¹ Furthermore, if the colors are placed in narrow stripes the "individuality" of both the color and the form becomes indistinct and will result in an 'optical mixture' with the colors appearing grayish and colorless.¹² Most successful, is if the boundary is broken by small indentations that confound the eye, producing a perfectly colorless tint. (see Figure 19).

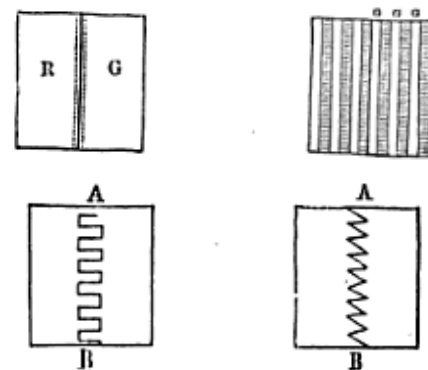


Figure 19. Diagrams illustrating the optical mixture, from Blanc's *Grammar of Painting and Engraving*.

Blanc is not only a fundamental influence of Seurat's early development as an artist but he introduced Seurat to Chevreul's laws of simultaneous contrast of color and tone, a key element to Seurat's paintings. The basis of Chevreul's theories deal with human perception and how the eye and brain work together to interpret a color. The theory of simultaneous contrast of color states that when two different colors are placed side by side, they will display maximum contrast. Furthermore,



Figure 20. Diagram illustrating complementary color pairs and simultaneous contrast of color, pl III of *Chevreul on Colours*.

when complementary colors are adjacent to one another they will clarify one another and appear more vibrant than in actuality or if viewed alone. While if two non-complementary colors are juxtaposed, their color will appear muddled. An example demonstrated by Chevreul in his work includes a red circle that is surrounded by a green halo; the former appears brighter, its luminance increased. (see Figure 20).

Similarly, in the theory of simultaneous contrast of tone, when two tones of a color are placed side by side, the lighter tone will be lowered and the darkest tone will be heightened (see Figure 21).

Throughout the mid-late 1800s, color theory was constantly evolving. It is important to note that primary colors as defined by both Chevreul and Blanc, include red, yellow and blue and when mixed they create a blackish color. Furthermore, the complementary secondary colors are produced by mixing pairs of the primaries: green is a combination of yellow and blue, violet is a combination of red and blue and orange is a combination of red and yellow. However, by 1852, the German physician and physicist Hermann von Helmholtz established the laws of additive and subtractive color mixing in his professorial thesis, *Theory of Combined color (Theorie der zusammengesetzten Farben)*. When these theories were presented at the time they were novel; Helmholtz revealed that the way that eye perceives color is through additive mixing and that white light consists of three primary colors, different from the primary colors defined by Chevreul and Blanc; an orange-red, green and blue-violet and when mixed, create white, not grayish black.

Scientists began further developing these theories, considering how the principles of additive color mixing can be applied to materials used in painting and represented on canvas.¹³ Around the same

time that Helmholtz was working, in 1850, the Scottish physicist Jams Clerk Maxwell, discovered that colors can not only be physically mixed on a palette for example, but also by the eye.

American physicist Ogden Rood built upon Maxwell's discoveries with experiments of his own, which he published in *Modern chromatics with Applications to Art and Industry* (1879). Rood's work is another early and major influence on Seurat's work, which he likely became acquainted with in 1881, when it was translated into French. This particular work may not have directly affected the creation of *Vase of Flowers*, but it is important in the development of

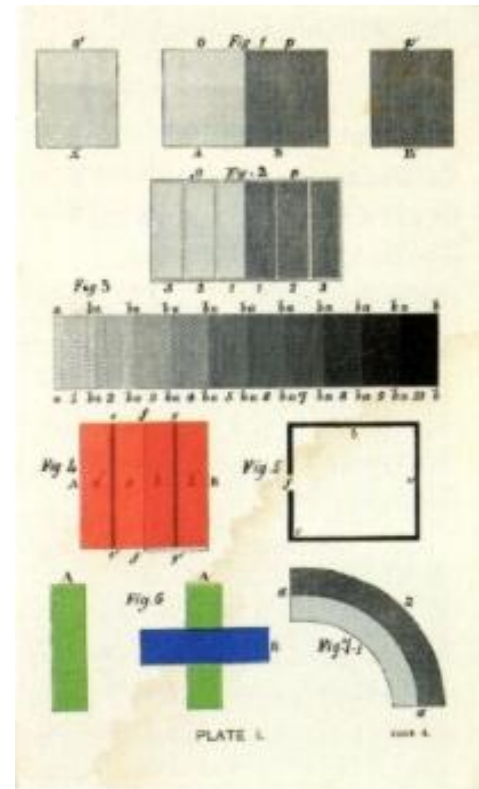
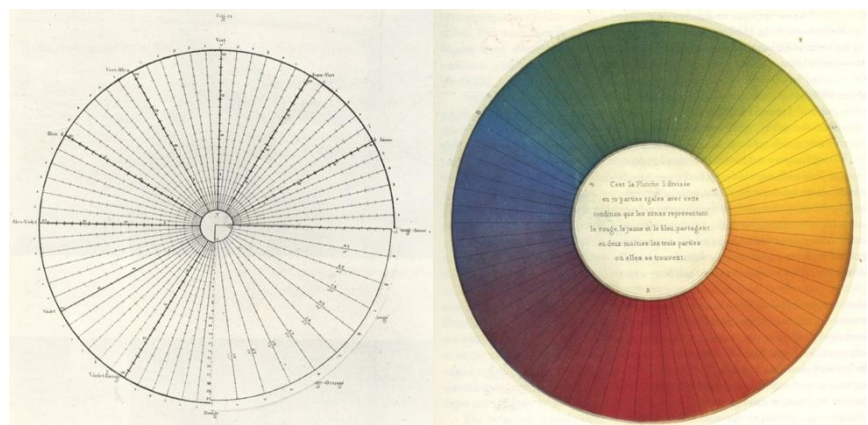


Figure 21 (above). Diagram illustrating tonal scales and simultaneous contrast of tone, pl. I of *Chevreul on Colours*.

Figure 22 (below). Chevreul's Chromatic Circles (divided into 72 colors).



Seurat's later technique and style. In addition, Rood painted as well and therefore applied both his own practical experience and scientific knowledge to color theory.¹⁴ Rood pointed out that "Chevreul had confused colored lights and colored pigments" and consequently through experiments, Rood constructed an accurate diagram of contrasting colors, in which the complementary to red, for example, is a greenish blue; green is the complementary to purple. From Rood, Seurat began applying the idea of contrasting hues to his work, painting strokes of purples next to greens rather than red next to green. Rood concluded that the luminosity of the optical mixture is far superior to that of a palette mixture.¹⁵

Furthermore, both Chevreul's and Rood's color wheel address the angle between two colors on the color wheel and how this relates to the harmony of the color; angles of less than 80° or 90° between two colors produce effects of contrast that are considered unsatisfactory and even inharmonious (see Figure 22). On the other hand, sets of three colors separated by angles of about 120° were often considered successful. Under certain circumstances, such as producing color gradation, a smaller interval between two colors will be very effective or if the color is viewed at the appropriate distance. In this way, the placement of small dots or lines of color side by side are blended by the eye (rather than creating a physical mixture of the paints on the palette). This method was described by Rood as "true mixtures of coloured light."¹⁶

Lastly of note are the influential theories of aesthete David Sutter, many of which deal with the aesthetic of line, composition and the analysis of antique sculpture. It is, however, his theories regarding color and chiaroscuro that are most relevant to Seurat's art. In an article written by Sutter that appeared in the journal *L'Art* in 1880, Sutter described "irradiation," as an effect that helps to increase definition of form; it is a luminous phenomenon that creates separation between two forms, producing high relief.¹⁷ In this way, color is used to create a chiaroscuro-effect in painting. Seurat uses "irradiation" extensively throughout *Bathers at Asnières*. Examples of it can be seen in the boundary created by the deep blue water edged by pale flesh or the white highlights surrounding the figures (see Figure 23). It not only helps to separate the figures from the background but gives them relief.

The work of certain scientists such as Helmholtz and Maxwell may not be directly related to Seurat's work and it is unlikely that he would have read their publications. However, their work was known to others such as Blanc, Chevreul and Rood, whose theories on color and harmony are of the utmost importance to Seurat and deeply penetrated his technical approach to painting throughout his career, though especially those early independent years when his technique was both methodical and experimental.

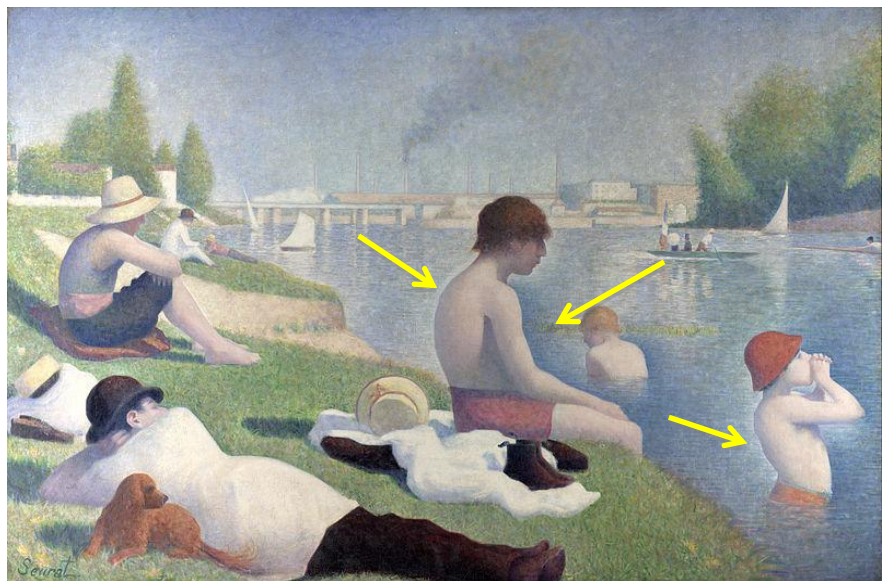


Figure 24. *Bathers at Asnières*, 1884, oil on canvas, 79.1 x 118.1 in., National Gallery of Art, London.

4. *Vase of Flowers*

Vase of Flowers is a stepping stone within Seurat's artistic career, a means of developing and advancing his painting technique. Closer examination of the quality of certain paint strokes, the way in which colors are juxtaposed and forms are shaped by brush strokes show Seurat developing his technique, thinking about an "optical formula" and how to use it in conjunction with his tools and materials to best represent a subject. Furthermore, there is a certain amount of freedom and experimentation in *Vase of Flowers*; colors, highlights and compositional elements are reworked showing uncertainty.

Vase of Flowers dates to the time Seurat left the École and began working independent of any institution. The painting depicts a vase of red hydrangeas in a white Asian-inspired vase on a table, covered with an off-white cloth. The table is positioned off center within the composition, though the vase is centrally placed on a corner of the table. The light source comes from the proper right side of the painting, creating streaks of sunlight on the tablecloth. The background is a myriad of short strokes of colors thoughtfully placed to create an overall deep maroon color. The painting is a rare example of Seurat's pre-pointillist work and it is his only known painted still-life.

Vase of Flowers came into the Harvard Art Museum's collection in 1974, with no information regarding its treatment history. It is oil (est) paint on canvas that has a tight and even plain weave. The painting is 18 1/4 x 15 3/16 inches, measured height by width. The ground is off-white in color and most likely artist applied, though using a proprietary pigment mixture. There is a fair amount of textured brushworking throughout the composition and some areas of impasto along the left, top and right edges. The painting is covered in thick yellowed varnish, none of which is believed to be original. In 1887, Seurat begins a letter to Octavas Maus "It is appropriate that I tell you of my horror of varnish..." going on to say, "VETO. I am against any varnishing of my canvases, either free or for a fee."¹⁸ Currently, the painting is in good condition, though lined and no longer on its original stretcher and covered with a thick and discolored varnish. For the full Condition Report see Appendix 2.

4.1. Technical Investigation of the Painted Structure

4.1.1. Ground

Four cross-sections were taken from *Vase of Flowers*, most of which have a thick ground, composed of one to three layers (see Figures 25-27) (see Appendix 3 for images of cross-sections). It is likely Seurat bought a proprietary pigment mixture containing lead white, barium sulfate and a small amount of yellow ochre from which he made his ground. As noted by Leslie Carlyle, lead white was often adulterated with materials such as starch, chalk, powdered talc, gypsum, various "chalky earths" and barium sulphate.¹⁹ These different

materials were frequently added to reduce the cost of production of lead white or even to help prevent the darkening

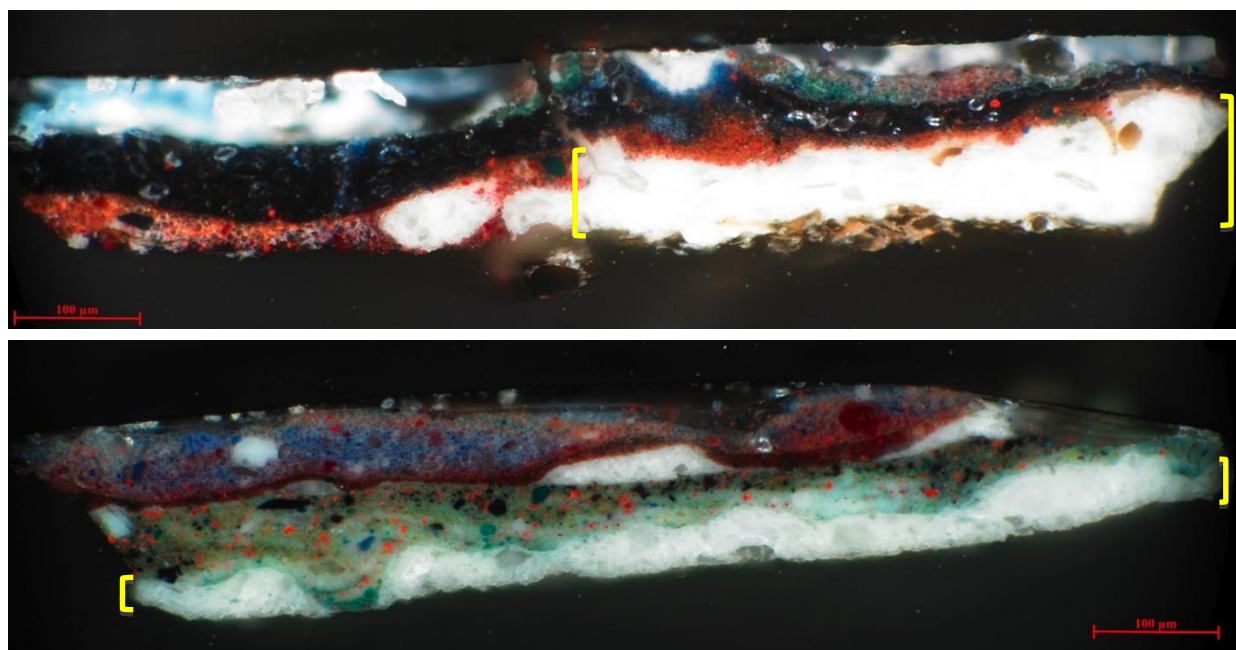


Figure 25. Location of the four cross-sections taken from *Vase of Flowers*.

of lead white by polluted air (hydrogen sulphide). In addition, barium sulphate was often listed as a substantial ingredient in various whites, for example Venetian white could consist of 50 % barium sulphate or Dutch white, which could have 75% barium sulphate.²⁰ Furthermore, in the 19th century, light colored grounds, either white or cream colored were preferred. For this reason, yellow ochre would often be used to tone the ground to an appropriate color.

In general, Seurat tended to use light colored or white grounds. In some cases he used commercially primed canvases and then applied his own ground on top.

On some of Seurat's later finished paintings, dating from 1883-90, commercially applied grounds were identified, which he tended to favor.²¹ In the few cases in which the ground was completely artist-applied, the layer(s) were composed of chalk, lead white or a combination of the two. Furthermore, silica was identified in a few of these ground layers.

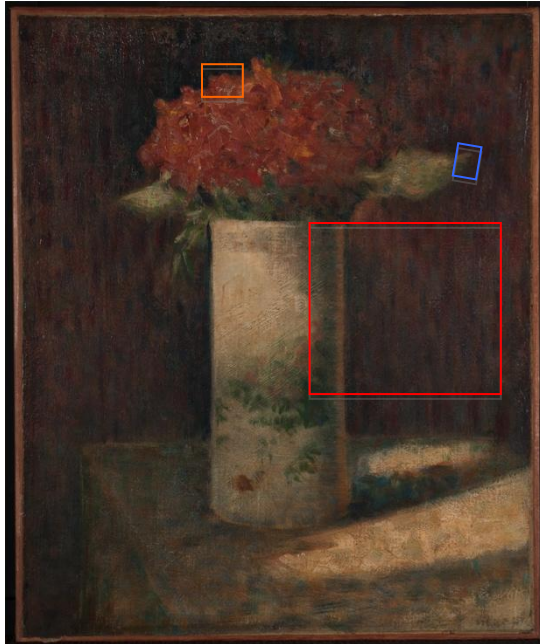


Figures 26 (top) and 27 (bottom): Cross-section 1(bottom) and 2 (top) from *Vase of Flowers*, bright Field Illumination. The yellow brackets indicate the ground layer.

4.1.2. The Paint Layering System and Technical Application Methods

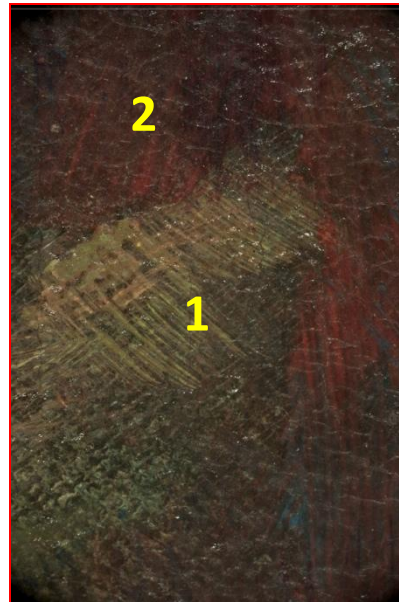
The painted structure of *Vase of Flowers* is complex and shows just how much forethought and planning Seurat invested in a painting. Unlike Seurat's academic or finished paintings, no underdrawing was found with IR, nor were reserves used on *Vase of Flowers*. In general, throughout his artistic career, Seurat left reserves for principal elements of a composition on finished works and even on some sketches, though his use of preparatory drawings, painted sketches and reserves was not consistent. In *Bathers at Asnières* for example, a preliminary drawing in charcoal or conté was found and he left reserves for main elements. On *A Sunday on the Island of La Grande Jatte*, Seurat used a grid system drawn in black conté that helped delineate the composition. In his late technique, Seurat would sometimes use cobalt blue for a preparatory sketch or to outline a design area.

In the painted structure of *Vase of Flowers*, one of the lower, visible layers is a light tan imprimatura. It is visible throughout the composition, especially in the table. Although it is the lowest visible layer, this does not necessarily mean it is painted directly on top of the ground (see Figures 28, 29 and 31). Next, a green layer was painted that extends into the background and under the bouquet, as indicated by the yellow arrows in Figure 29. The background was then painted on top of the green layer, used to define the shape of the leaves and bouquet (see Figure 30). In Figure 30, it is clear that the pink strokes of the background are on top of the green paint layers. In Figure 31, the yellow arrows indicate the different layers: layered on top of the green layers (1) is the bouquet (2), then on top of the background (3) is the deep blue halo (4).

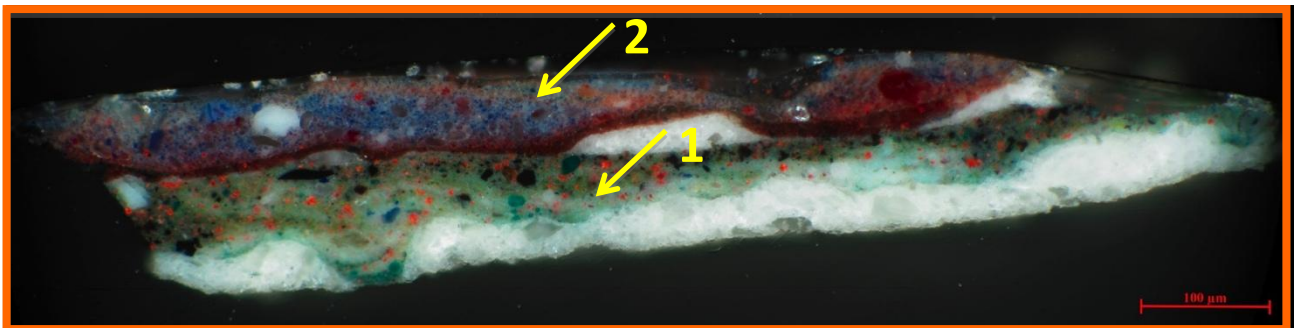


Clockwise: Figure 28. *Vase of Flowers* with location of detail images and photomicrographs; Figure 29. Detail of paint layering; Figure 30. photomicrograph at 7.9x; Figure 31. photomicrograph at 7.9x. Yellow Arrows: (1) the green layer (leaves); (2) The red bouquet; (3) The background; (4) The deep blue halo.

Cross-sections also helped to better understand the layering structure of the painting. In cross-section 2, Figure 27, taken from the impasto on the right edge of the painting, the bottom half of the section is composed of many thin green layers that make-up the green leaves, while the upper half of the cross-section, the blue and red layers, compose the background. This is also illustrated by Figures 31-33, in which the yellow numbers indicate these different layers on a photomicrograph and cross-section 2: (1) indicates the green paint layers that compose the green leaves and (2) indicates the red and blue layers that compose the background.



Clockwise: Figure 31. *Vase of Flowers* with location photomicrograph and cross-section; Figure 32. photomicrograph at 7.9x. (1) The green paint layers that compose the green leaves, (2) The red and blue layers that compose the background; Figure 33. Cross-section 2. 1) The green paint layers that compose the green leaves, (2) The red and blue layers that compose the background.



This complexity of layering is not unique to *Vase of Flowers*; other works, such as *Bathers at Asnières* show similar paint structures (see Figure 34). Rather than complex paint mixtures, Seurat superimposed many thin transparent or semi-transparent paint layers. In addition, cross-sections show that many of the layers were applied wet-in-wet, such as the yellow-green layers that compose the green leaves in cross-section 2. There is however, a distinct boundary in the same cross-section between the green layers and blue/red layers, indicating Seurat allowed enough time to pass for the green paint layers to dry and a skin to form before applying the violet shades of the background.

One of the distinguishing characteristics of Seurat's layering system in *Vase of Flowers* is the strong prominent brushwork throughout most of the composition. Visually, this is most obvious in the center of the painting (see Figure 35 and 36). This brushwork has no correlation to the painted objects within the composition and from cross-sections, it is clear this layer is not a ground layer. As seen in cross-section 2, Figure 37, this brushworking is found in-between other paint layers, the small patches of white paint between the greenish and red layers (indicated by the yellow arrows).

This brushworking was used as part of Seurat's technique of sanding or scraping away the top paint layers when the paint was dry or stiff enough to create distinct edges. Full examination of the painted surface under magnification helped to prove that this feature was not due to overcleaning; rather, Seurat used a strategic and complex layering system on top of the brushwork, to intentionally reveal layers below. Figures 38 and 39 help to illustrate the layering system used by Seurat over the prominent brushwork, as well as the strategic abrasion of layers.

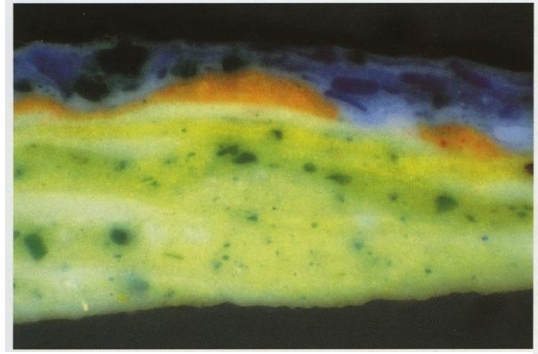
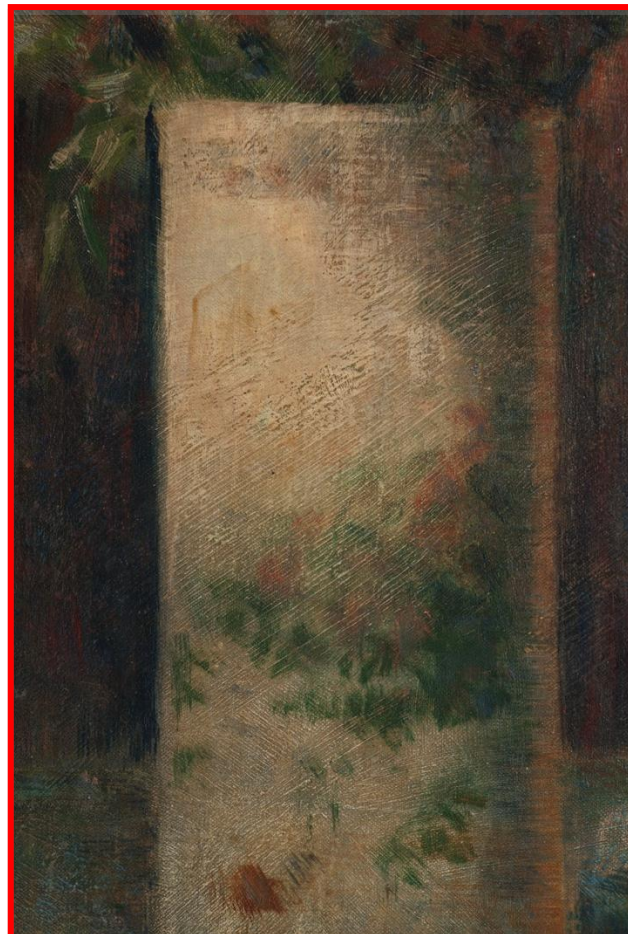


Figure 34. Cross-Section from *Bathers at Asnières* in foreground riverbank Photographed at 320x; actual magnification 250x. "Seurat's Painting Practice: Theory, Development and Technology." *National Gallery technical bulletin*. Vol. 24., 2003.



Figure 35 (left). *Vase of Flowers* with location of detail image.

Figure 36 (right). Detail of vase from *Vase of Flowers*.



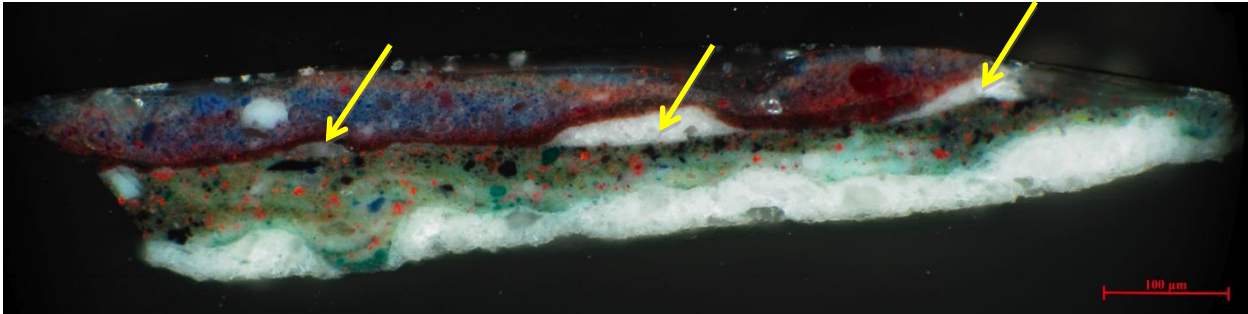
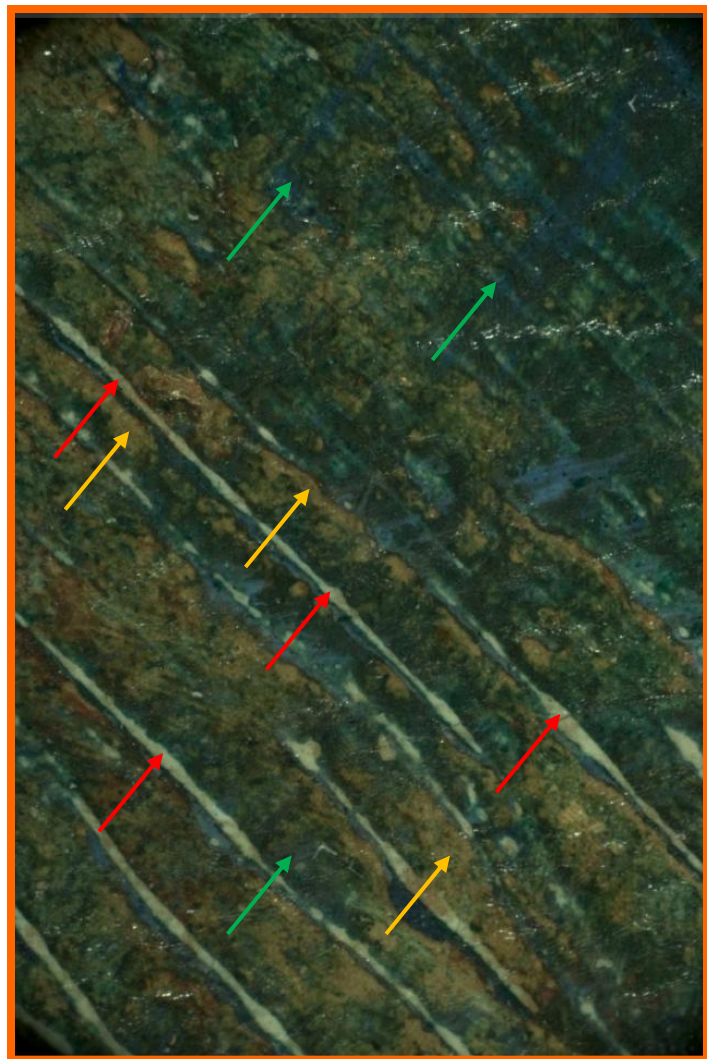


Figure 37. Cross-section 2. Yellow arrows indicate the small patches of white paint between the greenish and red layers that are the prominent brushworking.



Figure 38. *Vase of Flowers* with location of photomicrograph; Figure 39. photomicrograph at 25x. See (a.), (b.), (c.) below for description.

- a. **Red arrows:** These are the white peaks, the high points of the prominent brushworking.
- b. **Orange arrows:** The tan paint layer in the valleys of the brushwork was painted on top.
- c. **Green arrows:** next Seurat layered glazes of green and then blue paint.



After Seurat applied the first round of blue and green glazes, he sanded the surface to reveal the paint layers below and specific colors side by side. In Figure 39, the white brushwork was exposed leaving green/blue glazes to the left and right of the peak, which are then surrounded by the tan paint layer. After this process, he further reworked the area by painting more blue and green glazes on top of some of the exposed areas. This is most easily seen in the top left corner of Figure 39.

This technique is further visible in cross-section 1, Figure 26, taken from the top right edge of the painting. In this cross-section, the flattened top of the peak indicates the deliberate exposure of the area, revealing the blues and greens below. Lastly, from SEM-EDS analysis performed on cross-sections, the composition of the paint mixture used for the brushworking is similar to the composition of the ground layer, containing both lead white and barium sulfate.

From examination of other early works, there is evidence that Seurat used this technique on other paintings. For example, in *The Forest at Pontaubert* near the bottom left corner and middle of the painting, it appears that lower yellow paint layers were revealed after scraping away layers of green (see Figures 40 and 41).

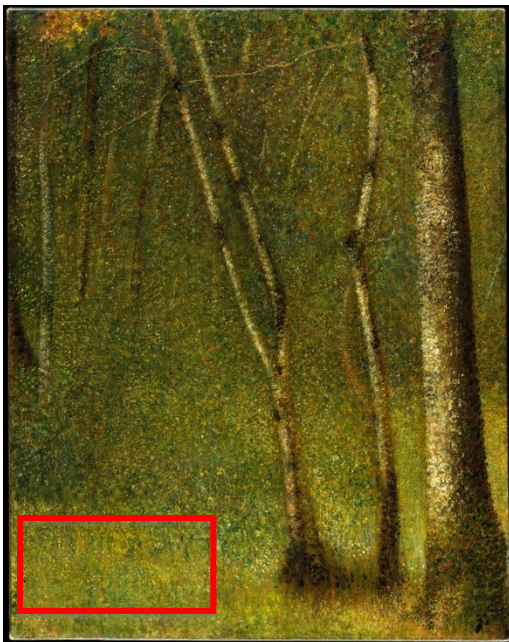


Figure 40 (left). *The Forest at Pontaubert*, 1881, Oil on canvas, 31 1/8 x 24 5/8 in., The Metropolitan Museum of Art, New York.

Figure 41 (below). Detail of sanded or abraded area of *The Forest at Pontaubert*.



4.1.3. Compositional Changes, Re-Working and Other Interesting Features

Examination of the X-radiograph helped to identify a number of interesting features, including compositional changes and evidence of reworking of the composition. Figures 42 and 43, identifies the compositional changes, including the shape of the table on the bottom left and adjustment of highlights on the vase and table, which were made larger in the final composition

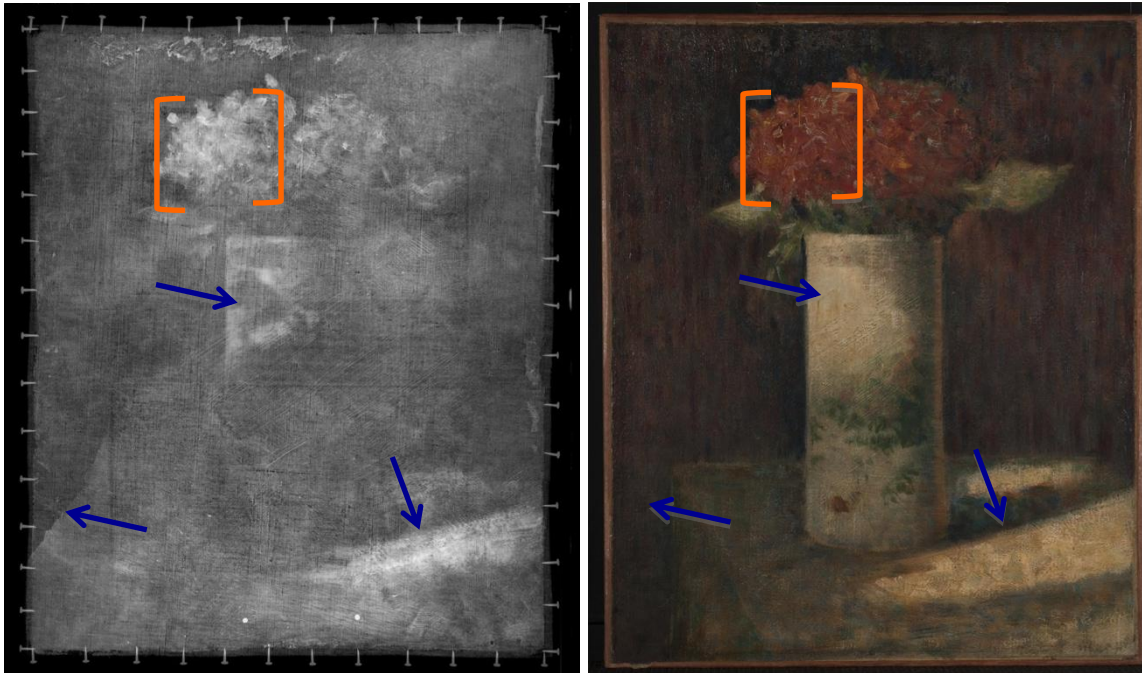


Figure 42 (left). *Vase of Flowers*, X-Radiograph Digital Composite. Blue arrows indicate compositional changes, orange brackets indicate reworked area.

Figure 43 (right). *Vase of Flowers*, Normal Illumination. Blue arrows indicate compositional changes, orange brackets indicate reworked area.

Figures 42 and 43 indicates areas of re-working in the X- radiograph; the left side of the bouquet was reworked, identifiable in the X-radiograph by the denser build up of paint.

There are a number of areas or clumps of impasto along the left, top and right edges of the painting, which are visible in both normal light as well as in the X-radiograph. In the latter they appear white, indicating they are composed of a dense material (see Figures 44 and 45). Even though these areas do not contribute to the composition, moating clearly suggests they were present when the painting was lined. The paint on top of them is seamless with the background, and there is no evidence that they were painted at a different time. Furthermore, two cross-sections take from areas of impasto show that the ground layer in these areas is especially thick (see Figures 26 and 27). The strongest argument for their presence is that as Seurat was applying the ground layer, he wiped excess paint from his brush on the edge of the painting leaving this buildup. This suggests that *Vase of Flowers* may have been a study, never intended to be a finished work of art.

Lastly, in the X-radiograph, creases along the edges of the painting that follow the edges of the impasto are visible (see Figures 46 and 47). Like the impasto, this feature doesn't correlate to anything on the face of the painting. Although examination of the edges of the canvas is limited due to paper tape that covers them, it is possible that the creases indicate the original fold of the tacking margin. It is likely, that when the painting was lined, the tacking margins were flattened and the composition enlarged.

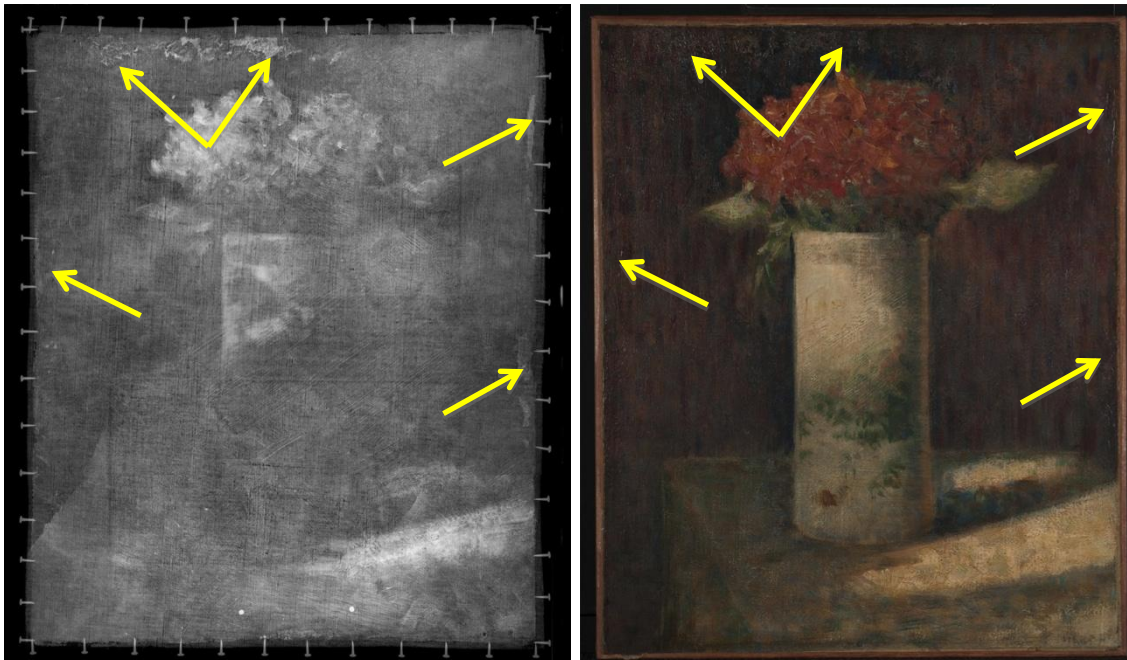


Figure 44 (left). *Vase of Flowers*, X-Radiograph Digital Composite. Yellow arrows indicate areas of impasto.
Figure 45 (right). *Vase of Flowers*, Normal Illumination. Yellow arrows indicate areas of impasto.

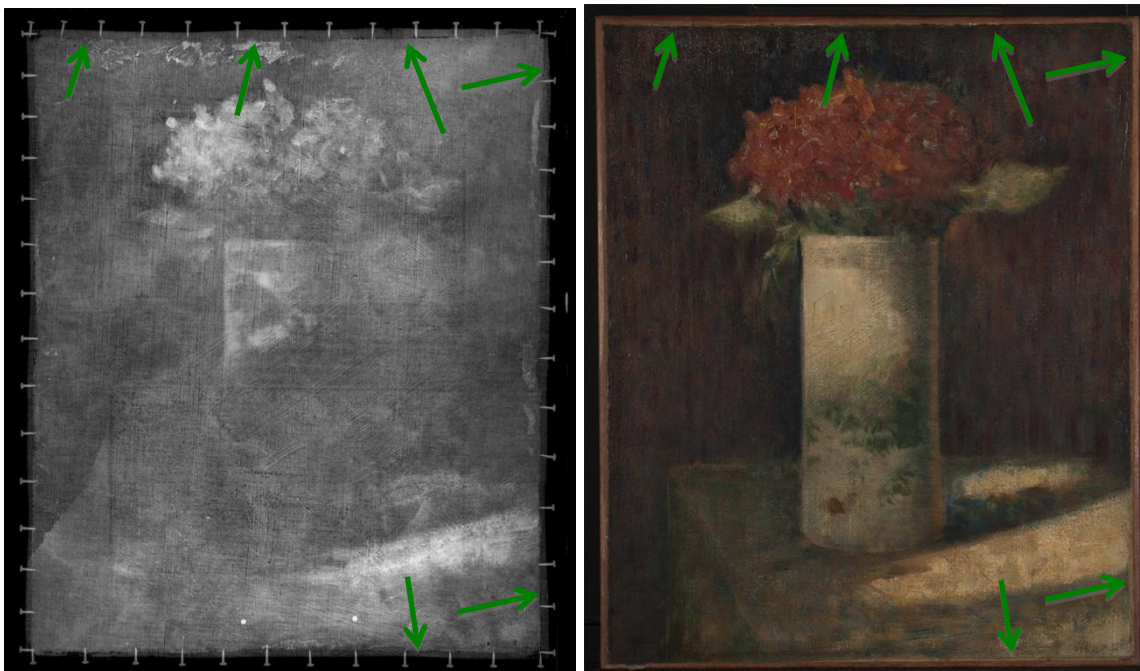


Figure 46 (left). *Vase of Flowers*, X-Radiograph Digital Composite. Green arrows possibly indicate original taking margins.
Figure 47 (right). *Vase of Flowers*, Normal Illumination. Green arrows possibly indicate original taking margins.

4.2. Mock-Ups

To better understand the unusual and prominent diagonally criss-crossed texture found throughout the painting and definitively prove that a similar surface could be achieved through technical means and not by overcleaning, mock-ups were made using canvas board and oil paint. Just how Seurat created this prominent brushwork and the technique he used to reveal paint layers below needed to be explained.

The canvas board used for the mock-ups came pre-stretched and primed with an acrylic gesso. Ultimately, titanium white paint was used to create the prominent brushwork, though tests were also made using lead white paint. The lead white paint tended to settle out rather than holding strong peaks, which were needed for the mock-ups. Despite that titanium white is not consistent with Seurat's palette, it was used to help achieve the best results. Various contrasting colors such as cadmium yellow, cobalt blue and brown earth were chosen for layering on top of the titanium white.



Figure 48. Mock-ups.

The prominent underlying brushwork was easy to create with a good stiff bristle brush, though the overall effect of the sanded or scraped paint was more difficult. Contrary to what was originally expected, it was by sanding the paint layers after they were completely dry, using a circular motion, rather than by scraping them while wet or semi-dry, that a surface similar to Seurat's was achieved (See Figure 49).

Tests were made daily as the prominent brushwork dried, by scraping the surface with a palette knife, razor or other sharp implement. This only resulted in smushing the peaks of the brushwork over the surface or lifting the skin that formed as it dried. Furthermore, the paint surface of the brushwork had to be dry enough and have formed a thick enough skin before any colored layers could be applied. If the colored layers were

applied too soon, they would disrupt and blend into the brushwork below. The only method that preserved the peaks of the brushwork and colored paint layers was by sanding the layers once completely dry. Even at this stage, when a palette knife or razor was used, it tended to abrade the whole surface and pull at it



Figure 48. Titanium white oil paint used to emulate prominent brushmarking.

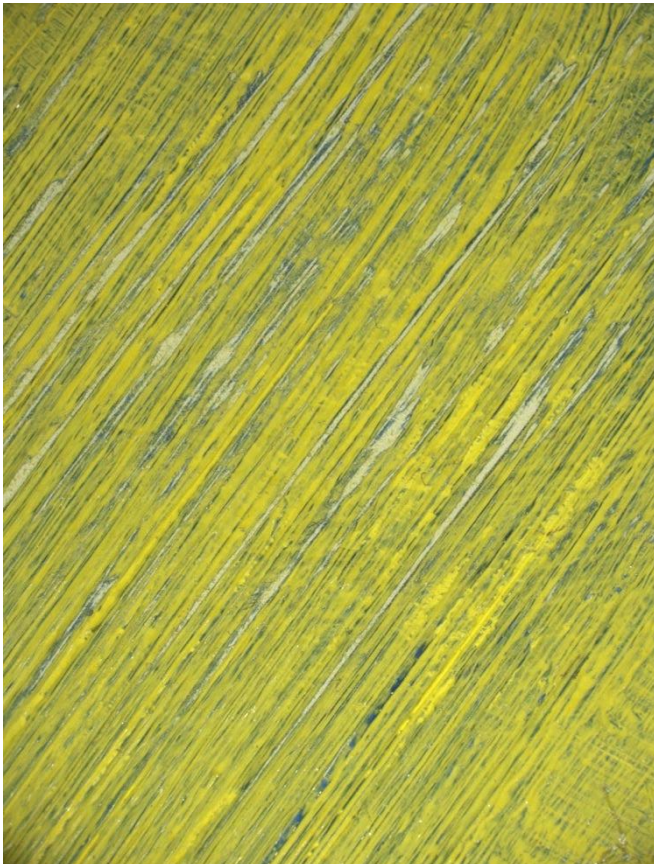
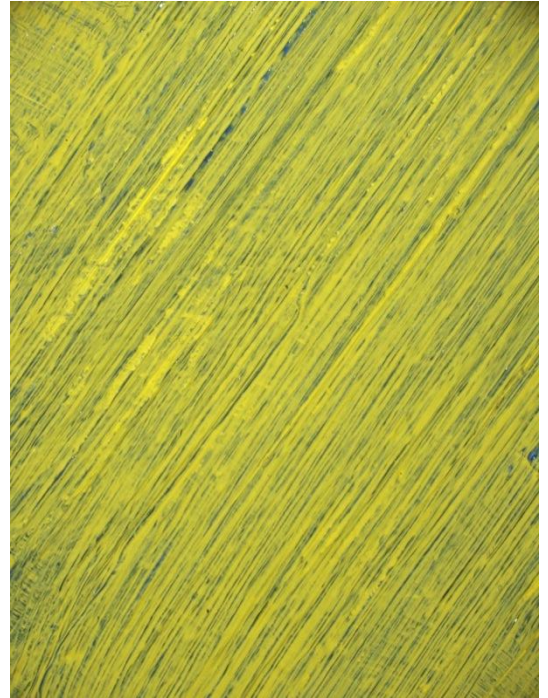
unevenly. The quality of Seurat's paint surface appears fine and intentional, while the effects achieved on the mock-ups using a palette knife or razor was clumsy and resulted in an ungainly surface.

During attempts to re-create the quality of Seurat's paint surface, the direction that the surface on the mock-ups was sanded made a difference in the overall effect of the revealed paint. Neither by solely sanding the surface against or in the direction of the prominent brushwork resulted in a surface similar to Seurat's; however, the effect was achieved by sanding the surface in a slightly circular or curved stroke and lifting the sandpaper after each stroke (rather than sanding the surface back and forth repeatedly) (see Figures 49-51).

Figures 49 (above right). Photomicrograph of mockup panel at 5x before sanding: stage 1.

Figure 50 (below left). Photomicrograph of mockup panel at 7.9x after some sanding: stage 2.

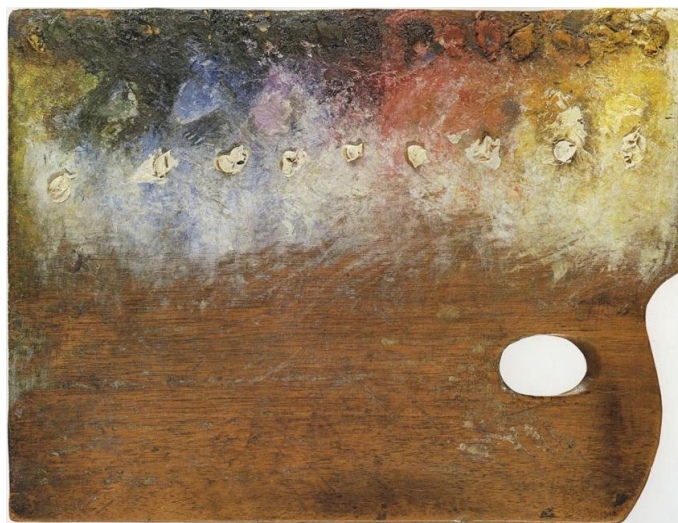
Figure 51 (below right). Photomicrograph of mockup panel at 12.6x after further sanding: stage 3.



4.3. Materials Identification: Palette

4.3.1. Seurat's Mature Palette

By 1886, when Seurat finished *La Grande Jatte* and was working in his mature style, he developed and was dedicated to a limited palette (see Figure 52). He used only pure spectral tube colors, laid out according to their order on the color wheel. Only adjacent colors on the palette could be mixed, never a color that was further away, this would muddy the color. Relative to Seurat's mature technique, in which his paint mixtures within a layer tend to be very simple, typically containing only one or two pigments, the paint layers in *Vase of Flowers* are much more complex, containing more pigments mixed within each layer. In Seurat's layering technique, he layered simple mixtures or glazes to create a specific color or effect, rather than adjusting a color by adding more pigments.



Figures 52. Seurat's palette from Mature Style, 1891, Musée d'Orsay.

Analysis of paint samples from Seurat's oeuvre by Kirby et al., indicate that he tended to use high quality materials, those that were not cheapened by the addition of extenders, cheap materials or fugitive pigments.²² Was there any analytical evidence of this for *Vase of Flowers*?

Seurat had a tendency to re-work his paintings, adjusting colors and brushstrokes at a later point. These adjustments have been identified through both materials identification and comparing the quality of brushstrokes. For example, when *Bathers at Asnières* was completed in 1884, Seurat tended to use larger controlled and directional brushstrokes, however small dots of color were found on and around the bathers that are more typical of the third phase of work on *La Grande Jatte*. These dots of color are believed to be painted in a last stage of painting around 1886-1887.²³

Seurat's palette was found in his studio after his death, though it has never been analyzed. However, from numerous technical studies his specific pigment choices are known. In general he only used two red, greens, blue, yellows, which were placed in the first row on the palette. These pigments include chrome yellow, emerald green, viridian, cobalt blue, French ultramarine; a mixed purple (ultramarine and red lake), madder lake, a mixed red (red lake and vermillion), vermillion, a mixed orange (vermillion and chrome yellow), Cadmium yellow (see Figure 52: pigments are listed as placed on the palette from the top left corner to the top right corner.). The second row is a series of tones, the same spectral colors mixed with lead white and lastly, the third row consists of daubs of pure lead white for mixing.

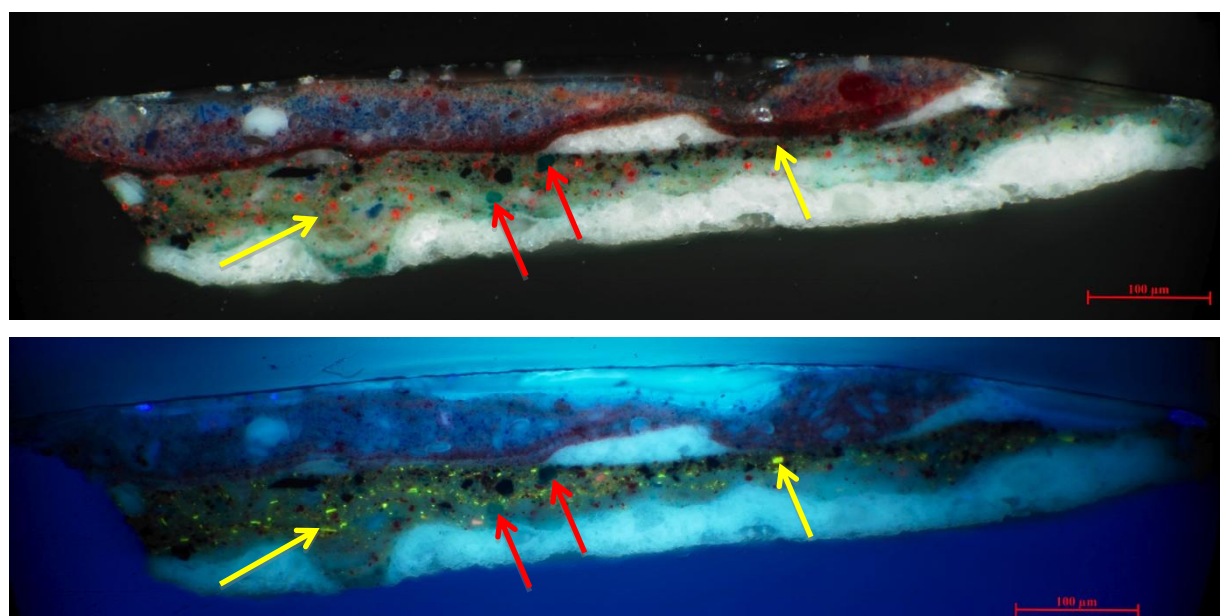
In a second version of the letter Seurat wrote to Félix Fénéon in 1890, he states he gave up the use of earth pigments, including yellow ochre, red ochre, sienna-type earth pigments and black pigments in

1882-1884.²⁴ This statement was not entirely true; though Seurat abandoned the use of earth and black pigments in his mature palette, yellow ochre has been identified in a few of his later works.

4.3.2. Pigment identification of *Vase of Flowers*

Pigment identification on four cross-sections was mainly carried out through SEM-EDS and XRF analysis. Figure 25 indicates the location of each cross-section, taken either from areas of actively flaking paint or areas of cracked paint.

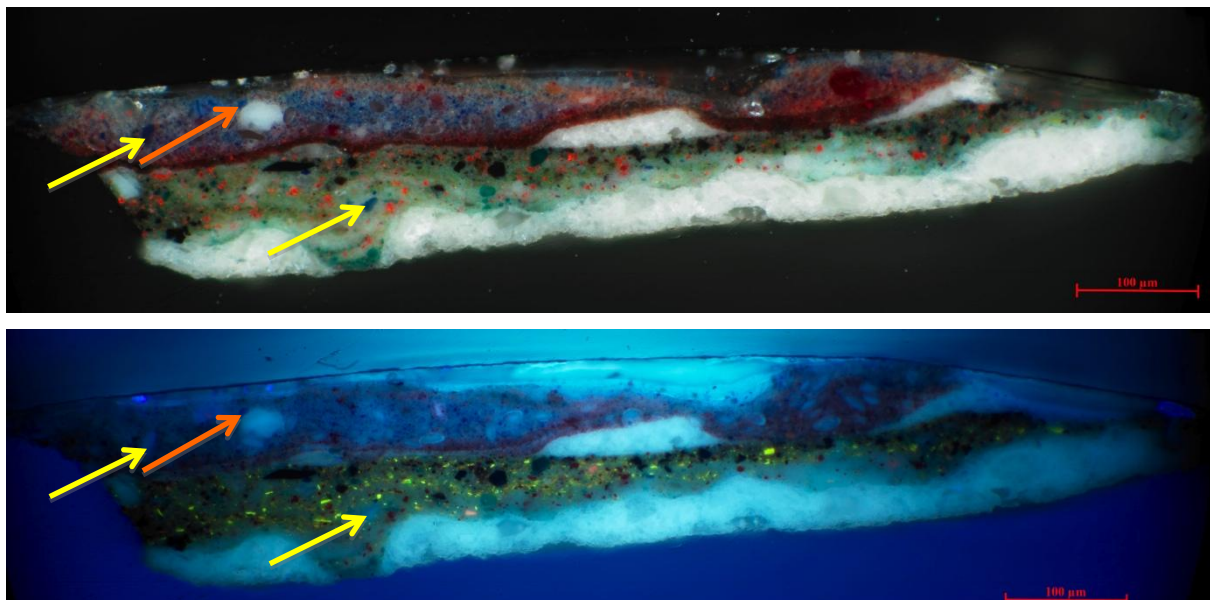
Through mainly SEM-EDS analysis, a chrome based green was identified, though no emerald green or other green pigments were found (see Figures 53 and 54: the red arrows indicate chrome based green particles).



Figures 53 (top) and 54 (bottom) Cross-section 2 in bright field illumination and ultraviolet induced fluorescence. The red arrows indicate chrome based green particles. The yellow arrows indicate Indian yellow particles.

Rather than the chrome or cadmium yellow pigments Seurat favored in his mature style, the only yellow pigment present in the cross-sections taken are thin rectangular particles of Indian yellow (see Figure 53 and 54, the yellow arrows indicate Indian yellow particles). The particles characteristically fluoresce like Indian yellow, and in SEM-EDS analysis, Mg was identified. The principle constituents of Indian yellow are calcium and magnesium salts of euxanthic acid, the active principle of mango leaves.²⁵ While the identification of Indian yellow in cross-sections was unexpected, it is not entirely unlikely. The pigment was still available to artists throughout the 19th century; it wasn't until 1908 that the Indian government prohibited the pigment's manufacture on inhuman grounds.²⁶ Furthermore, according to Merimee, in 1830, French supplies of Indian yellow were obtained through the English.²⁷ Although this pigment was not generally used by impressionist artists, it was identified in paintings by German 19th century artists.²⁸ Lastly, pigments of yellow organic dyestuff on a lead white substrate were identified in a number of paintings by Seurat in a survey conducted by the National Gallery, London.²⁹ The yellow dyestuff first appears on *Bathers at Asnières*, though it was used only sporadically afterwards.

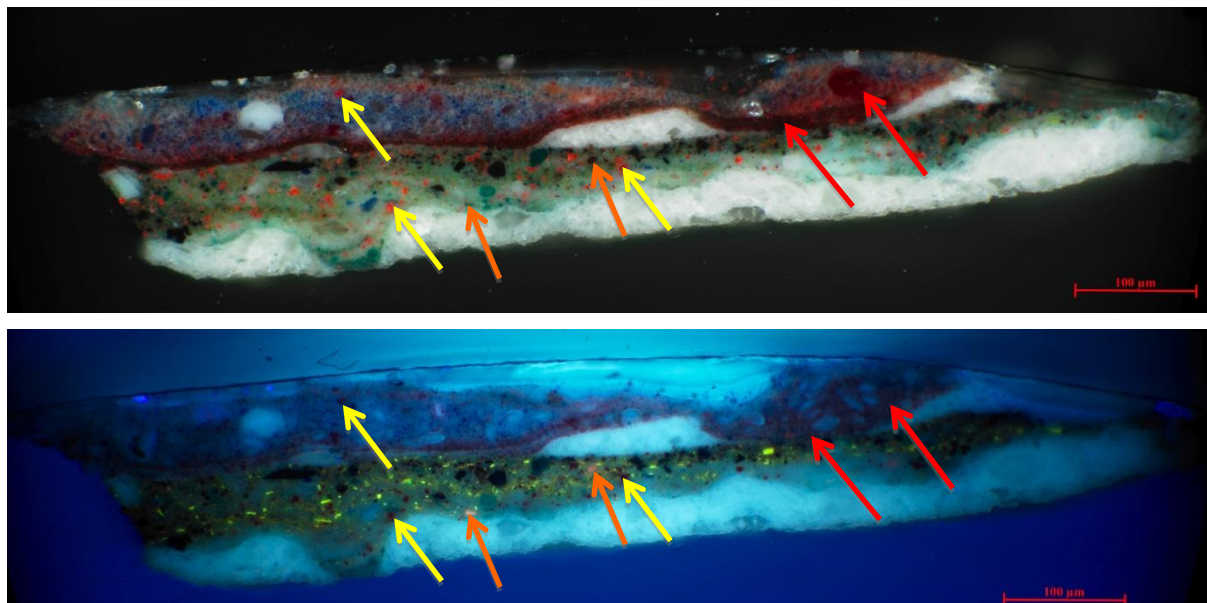
As in the actual palette, two blue pigments were identified, both cobalt blue and ultramarine. The cobalt blue is identifiable by its larger particle size, though it seems it was used more sparingly than ultramarine blue, which composes a bulk of the upper blue layers in cross-section 2 (see Figures 55 and 56: the yellow arrows indicate the cobalt blue particles. The orange arrows indicate the ultramarine blue particles.)



Figures 55 (top) and 56 (bottom) Cross-section 2 in bright field illumination and ultraviolet induced fluorescence. The yellow arrows indicate the cobalt blue particles. The orange arrows indicate the ultramarine blue particles.

Three different red pigments were identified in cross sections: vermilion and two different types of red lake, which is consistent with Seurat's mature palette. SEM-EDS identified particles of vermilion throughout the cross-sections, which are also identifiable by their orange-red color in normal light and lack of fluoresce under ultraviolet radiation (see Figures 57 and 58: The yellow arrows indicate the vermilion particles.). The two different red lakes were identified by their difference in fluorescence under ultraviolet radiation; some particles fluoresce a bright salmon-pink color while others had no fluorescence. The former's colored fluorescence is indicative of the plant based red lake, madder, while the later is most likely an insect based lake, known for its lack of fluorescence (see Figures 57 and 58: The orange arrows indicate the plant-based red lake (madder) particles. The red arrows indicate the insect-based red lake.). The insect based lake composes the red glazes in the upper portion of cross section 2 and is also found mixed with ultramarine throughout to make a purplish color. This is typical Seurat throughout his oeuvre; he preferentially mixed a red lake with ultramarine blue rather than vermilion to produce violet tones.

Previous studies have suggested that certain color combinations often found in Seurat's cross-sections may have been supplied by a colourman.³⁰ This may include the ultramarine blue and red lake mixture, as well as a green mixture identified in other paintings that included viridian with a touch of chrome yellow and lead white. The later was not found in *Vase of Flowers*. Instead, viridian or another chrome based green was mixed with Indian yellow.



Figures 57 (top) and 58 (bottom) Cross-section 2 in bright field illumination and ultraviolet induced fluorescence. The yellow arrows indicate the vermilion particles. The orange arrows indicate the plant-based red lake (madder) particles. The red arrows indicate the insect-based red lake.

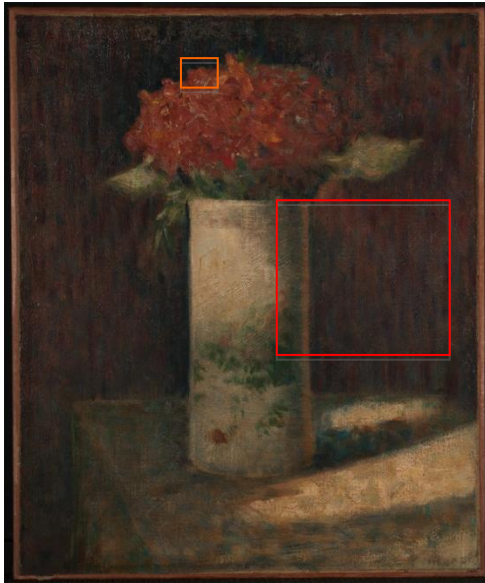
Although Seurat is known to have used both carbon and bone black during the first half of his career, only a few particles of carbon black were identified in the cross-sections taken. Similarly, SEM-EDS only identified areas of higher iron content, not individual particles, which indicates the use of some earth pigments but not a great deal. With XRF analysis, a large peak for iron was identified in the small red-brown stroke of paint in the bottom left corner of the vase (see Figure 1). This may be a mixture of a red earth with a small amount of vermilion

5. Applying Theories to *Vase of Flowers*

Understanding the point at which Seurat was in his artistic career when he painted *Vase of Flowers*, the aesthetic and scientific influences he pursued at the time, as well as the technical quality of the painting itself, helps to appreciate Seurat's application of scientific theory. In Seurat's diary, he took many notes, and copied quotes and diagrams from the writings of those that influenced him. One such passage that interested Seurat is from a section of Chevreul's book that focused on creating harmony of color by following the laws of simultaneous contrast of color and tone:

"To place color on a canvas is not just to colour with this colour that part of the canvas to which the pigment has been applied; it is also to colour the surrounding space with the complement color...to place white next to a colour is to heighten its tone, it is tantamount to removing from the color the white light that diminishes its intensity... to place a dark colour next to a different, lighter colour is to heighten the tone of the first and to dampen that of the second, independently of the change that result from the mixture of the complementaries."³¹

For *Vase of Flowers*, Seurat must have been thinking about Blanc's and Chevreul's theories on color placement as well as Delacroix's pairing of opposite colors. Seurat uses staggered broken and directional paint strokes of contrasting colors in the background, juxtaposing shades of deep red and pink, alongside shades of a deep blue and a lighter blue (see Figures 59 and 60). As Blanc described, Seurat places complementary colors alongside one another to produce the most striking optical mixture or maximum contrast as Chevreul stated in his laws of simultaneous contrast of color and tone.



Clockwise: Figure 59. *Vase of Flowers* with location of detail image and photomicrograph; Figure 60. Detail of staggered broken and directional paint strokes in background; Figure 61. Photomicrograph at 7.9 x. Detail of divided color, separated tints unblended.



Delacroix also used divided color; choosing to never apply a color evenly, he broke color into separate tints and never blended them on the canvas. This can be seen not only throughout the background but also in the bouquet of flowers, in the different tints of reds (see Figure 61). Following both Chevreul's theories on simultaneous contrast of tone and Delacroix's technique, in *Vase of Flowers*, juxtaposing them side by side to create a harmonious balance of color, as well as an effect more exciting to the eye than that of a single unified color.³² This technique of adjusting tones of a single color can also be found in the background, in which Seurat creates tonal contrast and a type of chiaroscuro effect with paint.

Further more, also following in the vein of Delacroix's work, Seurat places quick strokes of pale blues and yellows within the bouquet. This effect Seurat creates is the same he focuses on so accurately describing in his diary about the paintings by Delacroix.

Also inspired by Blanc's recommendation of "gradation" and the arrangement of dark and light, Seurat uses shorter criss-crossing brushstrokes of partially mixed paint, as seen in Figure 61. This type of brushstroke is common in Seurat's early work, though as his style progresses; it is a technique reserved mainly for painted studies (see Figures 62 and 63).

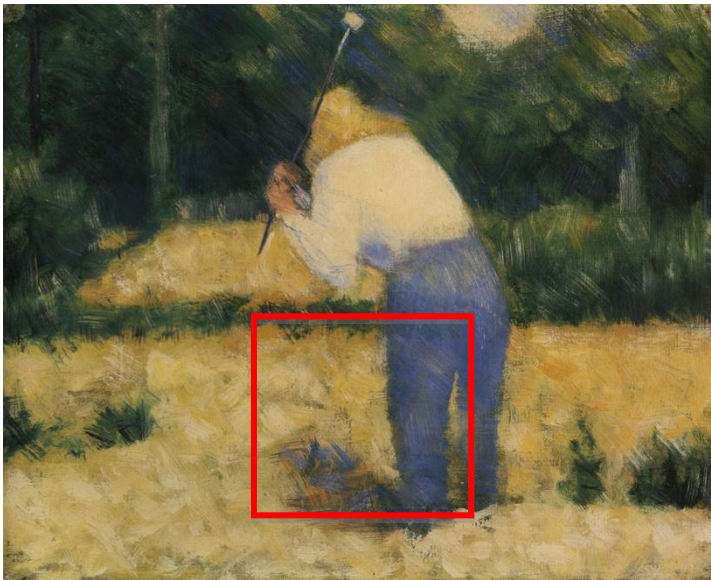


Figure 62 (left). *Stone Breaker*, c. 1882, oil on canvas, Private Collection.

Figure 63 (right) Detail from *Stone Breaker*.

Figure 64 (below right). *Vase of Flowers* with yellow arrows indicating blue halo.

In *Vase of Flowers*, Seurat explored what Sutter called

“Irradiation” in several passages of the painting. ‘Irradiation,’ the luminous phenomenon that creates separation between two forms, producing high relief, was created by the deep blue halo that contrasts with the reds flowers and background. This halo extends to surround the vase and table as well, further defining the forms that compose the still life and creating spatial depth within the composition (see Figure 64). In addition, the lighter highlights that Seurat placed on the edges of the vase and tablecloth intensify the luminous quality of the blue halo. While this effect doesn't seem as strong compared to Seurat's other works, it is important to note that the discolored varnish greatly mitigates Seurat's desired effect. Furthermore, this effect is commonplace throughout Seurat's oeuvre and late works as seen in *Young Woman Powdering Herself* (see Figure 16).



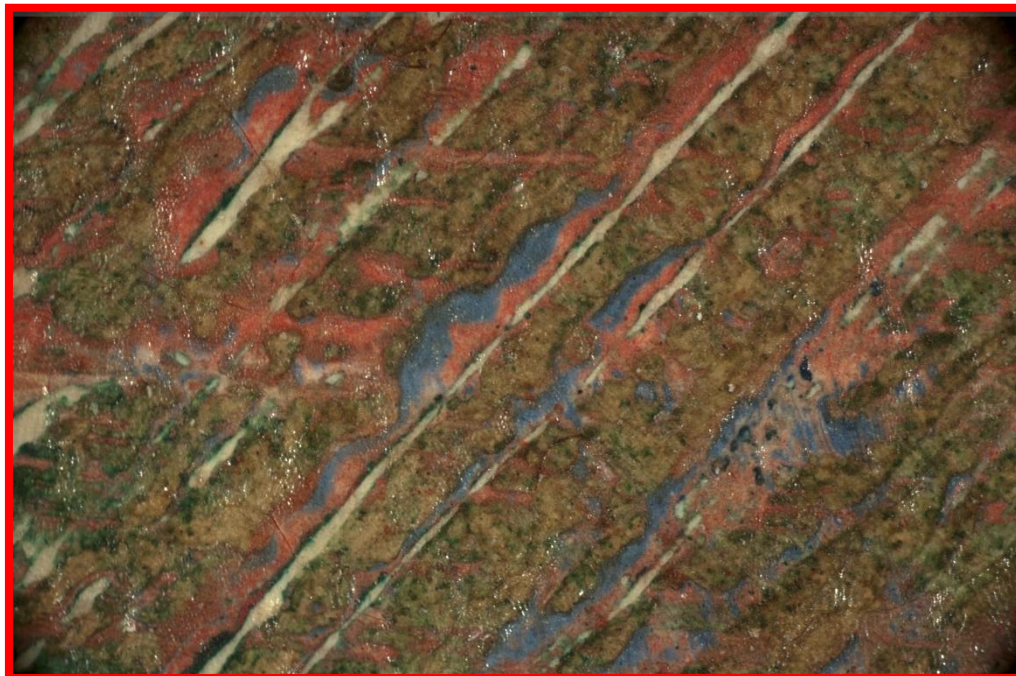
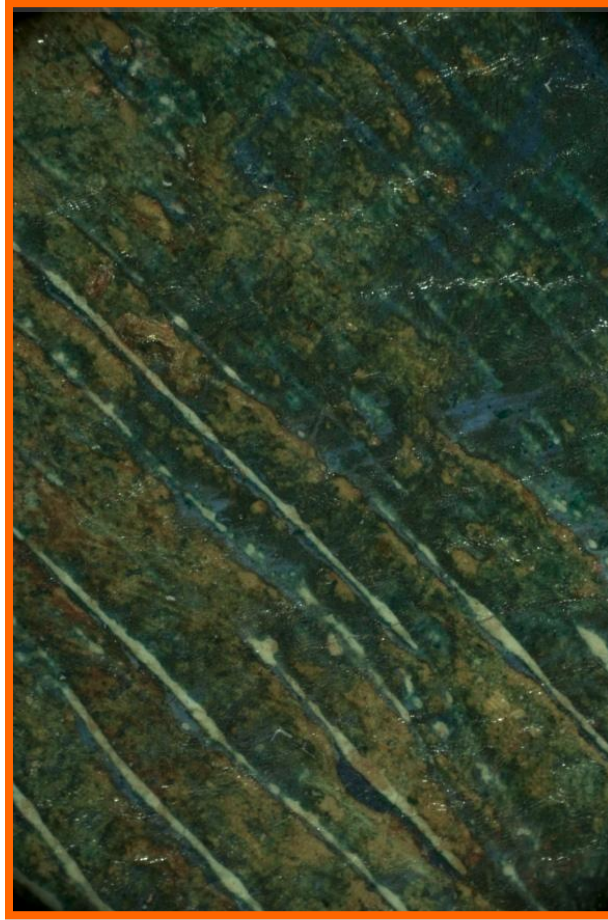
In using the scraping technique, Seurat also applies Chevreul's and Blanc's theory to canvas, just on a very small scale. He creates optical mixtures of contrasting tone as seen in Figure 66, or optical mixtures of contrasting color with the pinks and pale blues as seen in Figure 67.



Clockwise: Figure 65. *Vase of Flowers* with location of photomicrographs.

Figure 66. Photomicrograph at 25x.

Figure 67. Photomicrograph at 25x.



As Seurat develops his technique, many of the elements we see in *Vase of Flowers* remain; the execution of them just becomes more refined. This difference can be seen for example in the way Seurat achieves the effect of irradiation in *Vase of Flowers* versus *Young Woman Powdering Herself* (see Figures 68 and 69). In the former, the dark blue halo is painted in larger brushstrokes that abruptly and boldly contrast with the colors of the background. On the other hand, in *Young Woman Powdering Herself*, the brushstrokes are much smaller and finer, applied in the form of tiny dots. Furthermore, the dots are optically blended very carefully with the background, with the colors softer and gently gradated.



Figure 68 (left). *Young Woman Powdering Herself* with location of detail image.

Figure 69 (right). Detail from *Young Woman Powdering Herself*, “Seurat's Painting Practice: Theory, Development and Technology.” *National Gallery Technical Bulletin*. Vol. 24. 2003.

6. Conclusion

Seurat was a meticulous artist. He used materials and methods of paint application as a means of integrating theoretical concepts into his paintings. In his early use of such techniques as divided or criss-crossing brushwork and the scraping away of paint, we observe the development of pointillism and Seurat's creation of an aesthetic. In *Vase of Flowers*, Seurat applied thin dashes of color of varying length next to one another without blending or mixing on canvas, which developed into a smaller and tighter paint application of small dots or strokes of divided color later in his career.

At this early point in Seurat's career, as he searched for the means to best create his “optical formula,” his techniques of paint application were somewhat experimental. His early research led him to prefer particular pigments for their optical effect and his pigment choices for *Vase of Flowers* indicates that the use of pure spectral colors became ingrained from the beginning of his career. Seurat seemed to be experimenting with a number of different techniques in *Vase of Flowers*, though there was reason and theory behind every choice. *Vase of Flowers* can be viewed as a stepping-stone in Seurat's career, as he worked toward Pointillism.

By studying Seurat's technique and how he applied paint in *Vase of Flowers*, we have gained a greater understanding of why the painting looks as it does today. This study will hopefully lead to treatment, including removal of the varnish. Because it is so yellowed, the varnish greatly alters the appearance of the painted surface, obscuring the colors Seurat chose. Considering his preoccupation with brushstroke and color, as well as his documented aversion to varnish on his paintings, removing the varnish could deepen even further our understanding and appreciation of Seurat's painting techniques.

ENDNOTES

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- ¹ Homer 1964, p. 13.
 - ² Westmoreland 2012, p. 3.
 - ³ Hoenigswald 2009, p. 7.
 - ⁴ Herbert 1991, p. 377, Appendix B: Letter dated July 17 1923, from friend and painter, Aman-Jean to Seurat. Slightly different version quoted in Zimmerman 1991, p. 18 (also see endnote 10).
 - ⁵ Kirby et al 2003, p. 16-17 (see section ‘Seurat’s working practice’).
 - ⁶ Broude 1978, p. 13.
 - ⁷ Ibid, pp. 13-14.
 - ⁸ Ibid, 2.
 - ⁹ Zimmerman 1991, pp. 17-18.
 - ¹⁰ Zimmerman 1989, p. 202.
 - ¹¹ Blanc 1874, p. 162-164.
 - ¹² Herbert et al 2004, p. 43 (also see endnote 6). It was Blanc who coined the term ‘optical mixture,’ not Chevreul. Also see Charles Blanc, *Grammaire des arts du dessin*, Pris, 1867, pp. 610-612.
 - ¹³ Schaefer et al, p. 35.
 - ¹⁴ Ibid
 - ¹⁵ Smith 1997, pp 30-33 (see section ‘The Luminosity of Seurat’s Colour’).
 - ¹⁶ Herbert et al 2004, pp. 48-49.
 - ¹⁷ Ibid, p. 46.
 - ¹⁸ Herbert 1991, p. 405.
 - ¹⁹ Carlyle 2001, pp. 513-515
 - ²⁰ Ibid.
 - ²¹ Kirby et al 2003, p. 5 (Table 1), pp.17-19.
 - ²² Kirby et al 2003, pp. 19-27.
 - ²³ Herbert et al 2004, pp. 81-83.
 - ²⁴ Kirby et al 2003, pp. 19-27. Rewald 1962, p.82.
 - ²⁵ Feller et al 1986, pp. 17-21.
 - ²⁶ Ibid
 - ²⁷ Hofenk de Graaff et al 1991, pp. 76-85. Kirby et al 2003, p. 34, endnote 42.
 - ²⁸ Kühn 1975, p. 111.
 - ²⁹ Kirby et al 2003, p. 23 (also see endnote 44: the pigment found is intense bright yellow, with no tendency toward green or orange.)
 - ³⁰ Kirby et al 2003, pp. 21-22.
 - ³¹ Zimmerman 1991, p. 44.
 - ³² Homer 1964, pp. 29-36.

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Appendix 1. Letter to Félix Fénéon: Paris, June 20, 1890

Paris 20 juin 1890

Mon cher Fénéon

Permettez-moi de relever une inexactitude dans la biographie de Signac, ou plutôt pour écarter le doute permettez-moi de préciser.

- Elle résidait - C'était vers 1885. ^{Après la fin de l'expédition de Persano et de Signac fut plus lente}
 Je précise et je rétablis à 1885 pour finir les dates suivantes:

La fin de l'élément spectral étant la fin de
 votre style technique - ^{qui est} consacré par vous le premier
 cherchant Signac qui ne fut un jour en une ^{seule fois}
 sur cette base 1886-1884
 ayant eu Charles Blanc au collège et correspondant. Chacun
 et les préceptes de Delacroix pour cette raison.

Après lui des études sur les mêmes Charles Blanc sur la
 même peinture (galette de Beauvais Tome XVI, si j'ai bien
 compris) ^(comme d'habitude)
 connaissant les vices de son style sur le tout et les préceptes
 de Lantier sur la finesse des teintes (chose de son exposition)
 étant frappé par l'intuition de Monet et Persano
 partant avec certaines idées de Sutter sur l'art antique des Grecs
 à Brest (Journal l'art) Mars et Juin 1880

Rood m'ayant été signalé par un article de Philippe Gille
 Figs 1881

Je tiens à établir les dates suivantes indiquant ma paternité
 antérieure

1884 Grande jatte chez ~~le dépôt des indépendants~~
 1884-1885 grande jatte composition
 1888 ~~entraîné~~ à la grande jatte et à grand camp

après la grande jatte composition 1886 Octobre
 Octobre 85 ~~la fin de l'expédition de Persano~~ chez Duran Ries
 1886 Janvier ou février petite toile de Persano
 chez Elzot le marchand de la rue d'Arcole d'un souscripteur
 Signac définitivement convaincu et ami venait de
 modifier les motifs dans ~~mon~~ ^{un même temps que je terminais la jatte} ma
 technique récente:

1. le passage du point. Brest. Clichy. Mars avril 1886
2. les gorgonnières Clichy. Mars. Avril 1886

(Catalogue d'indépendants pour ces raisons)

Fruit avec Guillaume qui m'avait fait connaître
 Persano et qui se voyait par la même occasion de Signac
 Nous sommes qu'il y a une nuance et que si j'ai air
 inconnu je n'en ai pas moins moi et ma vision
 que vous venez de dicter si supérieurement d'une façon
 à part un ou deux détails insignifiants. ^{impersonnels}

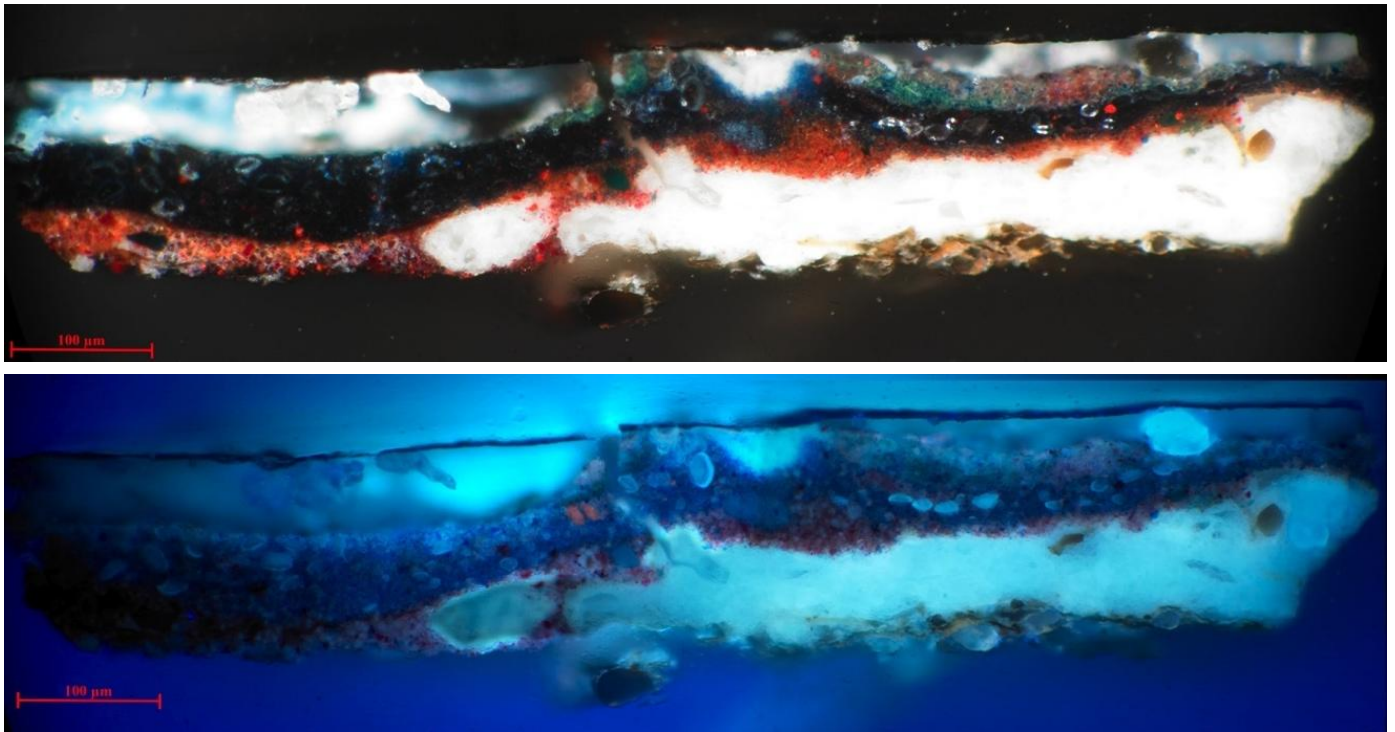
Déjà M. Beuville m'avait sacrifié à Charles Henry que
 nous ne connaissons pas avant la Rue Laffitte (rien expliqué)
 C'est chez Robert Lape que nous avons été mis en rapport
 avec plusieurs esprits de l'art de la rue (Piot Botton
 Duarte et de Laffitte)

Persano est venu la avec Guillaume.

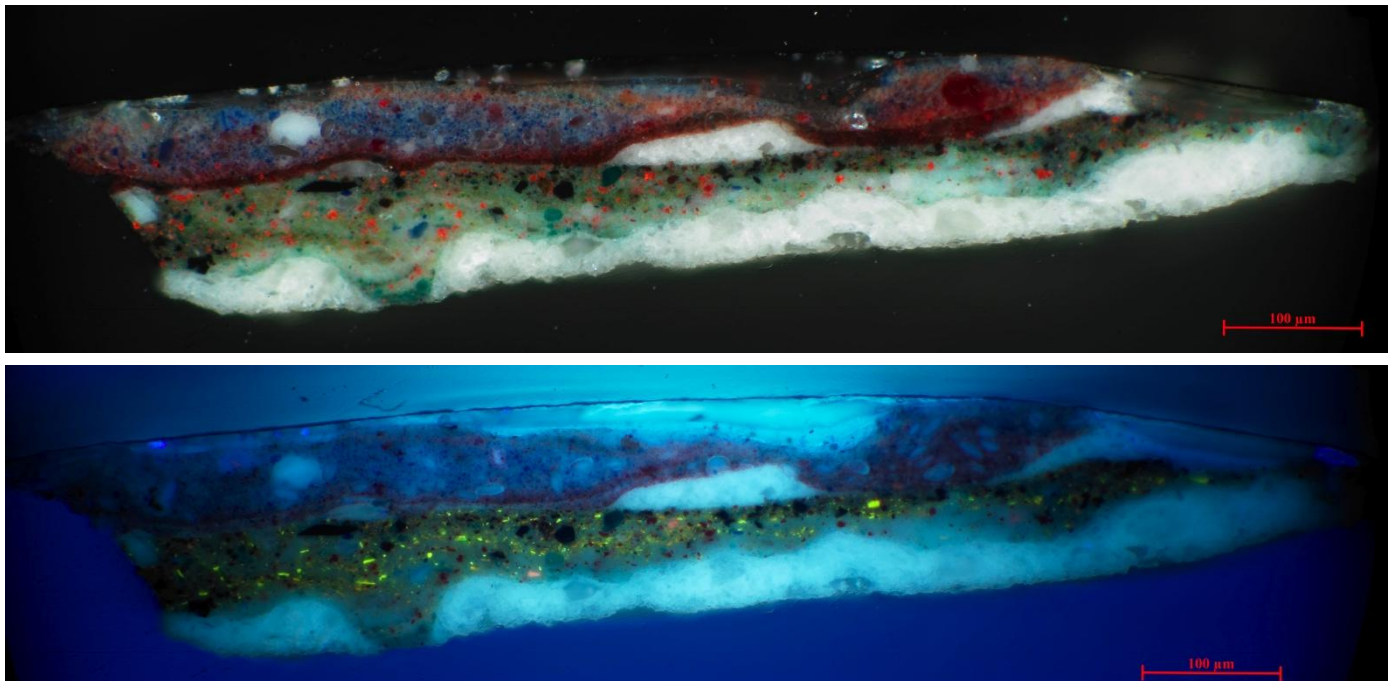
Puis nous m'avez sorti de l'ombre avec Signac qui a bénéficié de ^{nos}
 recherches sur votre langage nous communiquant les notes de M. Jules Chéret, Lape
 et Beuville nous ont radicalement et loyalement la main serrée

Figure 1. Georges Seurat, Letter to Félix Fénéon June 20, 1890, in the collection of César de Hauke.

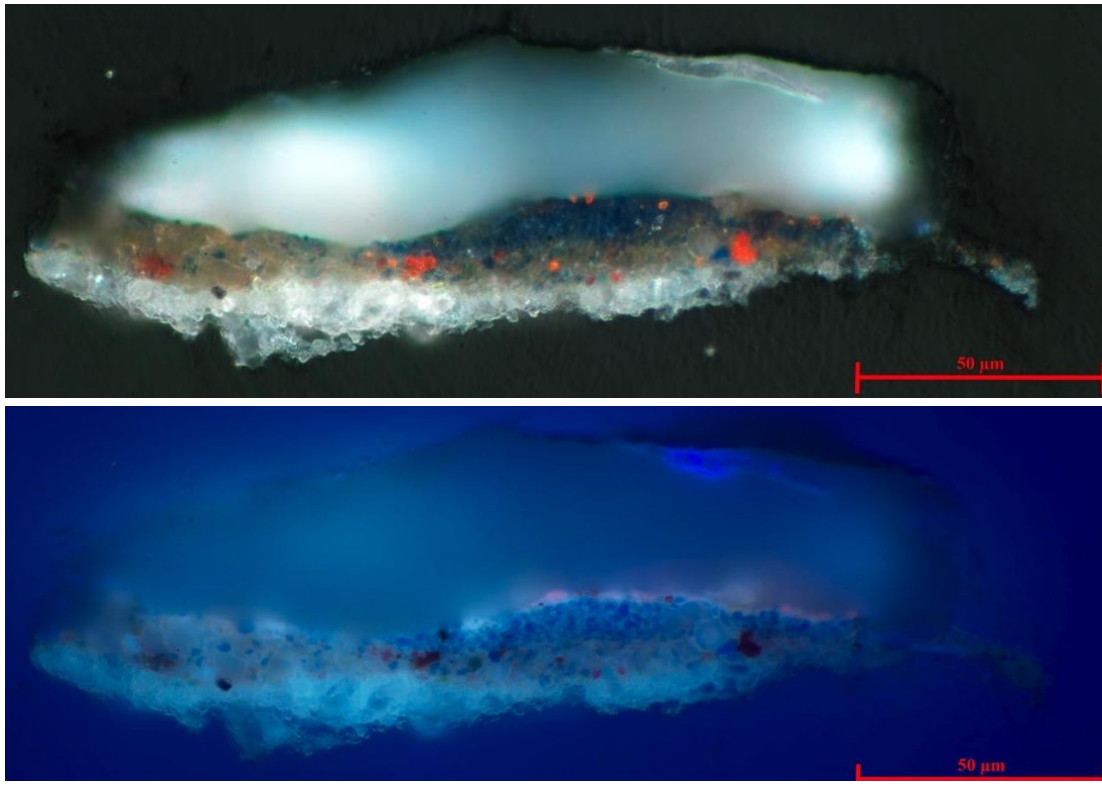
Appendix 2. Images of Cross-sections



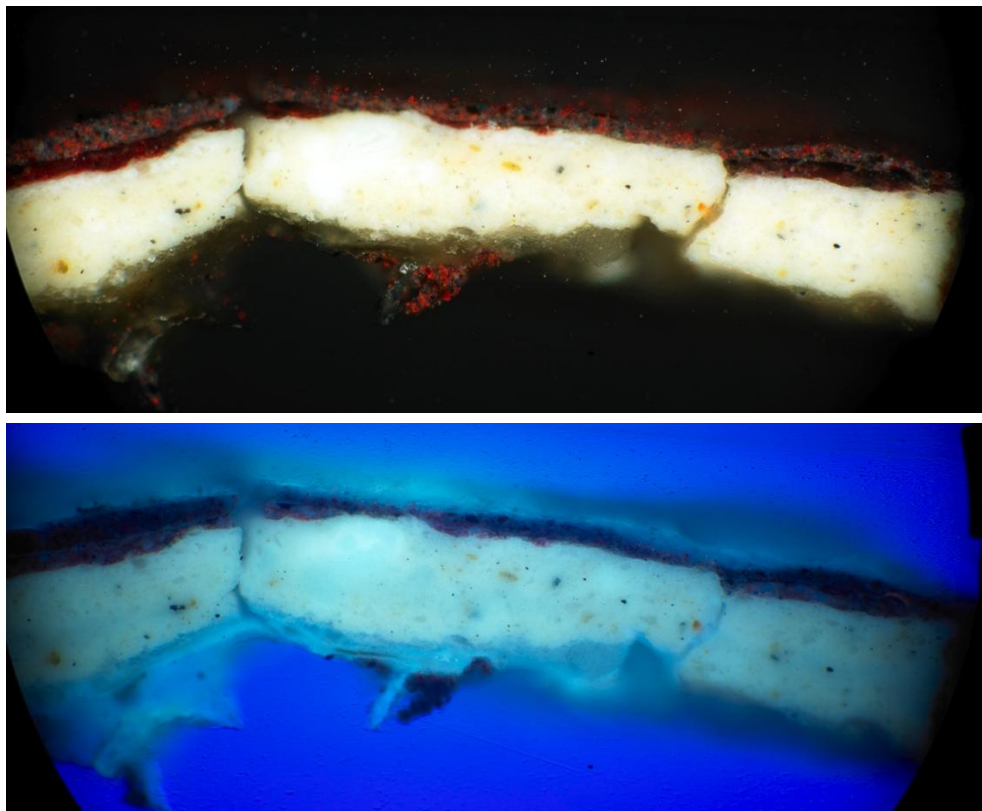
Figures 20 (top) and 21 (bottom): Cross-section 1 from *Vase of Flowers*. Top: Bright Field Illumination. Bottom: Ultraviolet Induced Fluorescence.



Figures 22 (top) and 23 (bottom): Cross-section 2 from *Vase of Flowers*. Top: Bright Field Illumination. Bottom: Ultraviolet Induced Fluorescence.



Figures 24 (top) and 25 (bottom): Cross-section 3 from *Vase of Flowers*. Top: Bright Field Illumination. Bottom: Ultraviolet Induced Fluorescence.



Figures 26 (top) and 27 (bottom): Cross-section 4 from *Vase of Flowers*. Top: Bright Field Illumination. Bottom: Ultraviolet Induced Fluorescence.

Appendix 3. Condition Report, Treatment Proposal and Treatment Report for Vase of Flowers

32 Quincy Street, Cambridge, MA 02138
www.harvardartmuseums.org

Harvard / Fogg Museum
Art Museums / Busch-Reisinger Museum
Arthur M. Sackler Museum

CONDITION REPORT

Artist: Georges Pierre Seurat, 1859 - 1891

Culture: French

Title: Vase of Flowers

Dated: c. 1878-c. 1879

Medium: Oil on canvas

Dimensions: framed: 72 x 64.4 x 8.3 cm (28 3/8 x 25 3/8 x 3 1/4 in.)

Credit Line: Harvard Art Museums/Fogg Museum, Bequest from the Collection of Maurice Wertheim, Class of 1906

Type: Painting

Object Number: 1974.100

Description:

The painting depicts a vase of red hydrangeas in a white Asian-inspired vase on a table, covered with an off-white cloth. The table is positioned off center within the composition, though the vase is centrally placed on a corner of the table. The light source comes from the right side of the painting, creating streaks of sunlight on the tablecloth. The background is a myriad of colors thoughtfully painted to create an overall deep maroon color.

Support:

Construction:

The painting is tacked to a wooden keyable stretcher that is composed of four exterior members with mortise and tenon joins and one horizontal cross member. All ten of the keys are present. There are a few inscriptions on the back of the stretcher: written in blue media on the right side of the top member is "47019F" and above "x" is written in graphite on both the top and right stretch member where they meet at the join. Lastly, tacked to the bottom member is a sealed enclosure with two small labels from another stretcher.

The painting is lined to a finely woven canvas with a tight and even plain weave. The original canvas also appears to be finely woven with a tight plain weave, though it is difficult to exam due to the thick paint layers and that the original tacking margins were cut off during a previous lining process. During this process the painting was made slightly larger by leaving some of the tacking margins on the face of the painting. The edges of the painting are covered with brown paper tape that extends approximately ¼ inch on the face of the painting and 1 ¼ inches onto the back of the stretcher.

Condition:

The stretcher is planar and in good condition, though not the original stretcher for the painting. Both the lining canvas and original canvas are in good condition; they are well tensioned and the original canvas is kept in plane by the lining canvas.

Ground/Paint:

Construction:

The ground is off-white in color and most likely artist applied, though using a proprietary pigment mixture of lead white, barium sulfate and a small amount of yellow ochre. Overall, the ground is thick and composed of one to three layers. One of the preparatory layers is visible in some areas of the composition, used by Seurat to help define objects and create a halo around them that establishes spatial dimension within the composition. This effect was also created by the dark blue paint that surrounds the bouquet, edges of the vase and table. In other areas such as the foreground, the preparatory layers are also visible through the paint layers, contributing to the overall color and effect of the area.

The paint layers appear to be paste vehicular and vary in texture, thickness and complexity throughout. In some areas such as the white tablecloth, the layers are thin, applied using a drier paint application that left the ground easily visible. There are heavier strokes that have a prominent brush-marking texture that is visible throughout most of the composition. A large wide brush was used to apply these layers in diagonal strokes of varying length that created prominent ridges and peaks. Touches of slight impasto were used in the flowers and lastly, there are thinner glaze-like strokes on the vase. Areas of thick impasto are located along the top, left and right edge of the painting. The use of more medium rich, glaze-like layers are limited to the green and blue strokes in the vase and the darker red strokes in the background.

From examination of the paint layer and small losses along the edges of the painting using the stereomicroscope, paint layering is better understood (see section 4.1.2 of “Refining Style: Technical Investigation of an Early Work by Georges Pierre Seurat in the Maurice Wertheim Collection” for a detailed description of the layering system.) One of the lower, visible layers is a light tan imprimatura. Although it is the lowest visible layer, this does not necessarily mean it is painted directly on top of the ground. On top of this is a green layer was painted that extends into the background and under the bouquet, which is composed of multiple paint layers: layers of red, yellows and various shades of pink were mixed wet-in-wet and only partially mixed when applied. Lastly, small quick ribbons of light blue

and turquoise are scumbled on dry. The background is composed of vertical strokes of color of varying length layered on top of one another: blue and dark blue strokes were juxtaposed against dark salmon pink and red wine color. Finally on top of the background is the deep blue halo.

Some areas throughout the composition were strategically sanded or abraded by Seurat to reveal colors below, which includes the white ridges of the prominent brushwork. This technique is especially visible in the center of the painting, in the vase and lower section of the bouquet.

It is likely that Seurat left a reserve for the flowers and vase, which are not painted on top of the background. The paint strokes that compose the background help to define the shape of the bouquet and distinctly end before encroaching on the flowers.

The size of the pigments in layers varies from fine to very large and some of these larger particles are visible with the aid of a stereomicroscope, especially green and red pigment particles.

Condition:

Overall the ground and paint layer are in stable and good condition. The lining has kept the canvas and painting in plane, however it is possible that excessive heat and/or pressure were applied during the lining process and areas of impasto now appear squashed and flat.

There are a few minor paint losses, none of which are extremely visually distracting. There is a small loss in the top left corner located at $15 \frac{1}{4} \times 2 \frac{1}{2}$ inches, a few throughout the impasto along the top edge, another in the upper glaze/paint layer in bottom right corner located at $\frac{3}{4} \times 12 \frac{1}{2}$ inches (height x width, measured from the bottom left corner in inches).

It is likely that there were at least two phases of inpainting; one that is probably older and is underneath the varnish and then a more recent application that is closer to the surface. The inpainting is well-done and difficult to locate under normal illumination, though are visible under ultraviolet induced fluorescence, in which they appear dark, absorbing the ultraviolet radiation. The two areas of the older inpainting are located on the left side of the flowers where the red paint layer meets the background. There are small amounts of inpainting in all of the four corners and covering some of the edges of the painting, most likely covering paint loss and abrasion in the original tacking margins.

Surface Coatings:

Construction and Condition:

The painting is covered in a thick yellowed varnish that affects the overall color quality of the painting. There are micro-wrinkles in the upper varnish layer, visible under magnification. Under ultraviolet induced fluorescence, the varnish fluoresces a bright bluish-green color, most likely indicating the presence of a natural resin varnish. The extent of discoloration can be seen in the top left side of the white vase, where the varnish has pooled within a brush stroke. There are some areas where the fluorescence is darker, indicating there might be something underneath absorbing the ultraviolet radiation, possibly retouching. These areas are located on the left side of the painting, just above the flowers, as well

as a vertical line just above the left corner of the table. Overall, there is layer of surface grime on the painting.

Previous Treatment

During previous treatment the painting was removed from its original stretcher, cleaned, lined (est. animal glue) and then re-stretched onto a new stretcher. There is no documentation regarding this treatment and it occurred before the painting was acquired by Harvard Art Museums.

TREATMENT PROPOSAL

There are a few small areas of flaking and lifting paint that are in need of consolidation. These are located along the top edge of the painting, in areas of impasto and near the bottom edge of the painting. These areas must be consolidated prior to removal of surface grime, which would otherwise run the risk of paint loss. It would be ideal to take samples from these areas of damage before consolidation; if the areas are consolidated first, the paint layers become infused with the consolidant and make studying the paint layers more difficult.

1. Perform before, during, and after treatment documentation including digital photography.
2. Take cross-section samples in areas of flaking/lifting paint.
3. Consolidate areas of lifting with sturgeon glue.
4. Clean surface grime using a 2% solution of triammonium citrate.
5. Perform solvent tests to determine the appropriate method for varnish removal.
6. Discuss with curators Stephan Wolohojian and Elizabeth Rudy the results of testing and how treatment should proceed.
7. Possibly remove discolored varnish using the appropriate solvent(s).
8. Fill small losses with modostuc.
9. Inpaint small losses with Gamblin Conservation Colors diluted in isopropanol.

TREATMENT REPORT

1. Performed before, during, and after treatment documentation including digital photography.
2. Four cross-sections were taken in areas of flaking/lifting paint for analysis.
3. Consolidated areas of lifting with 3% sturgeon glue.
4. Aqueously cleaned surface grime using a 2% solution of trisodium citrate.