

# Revolution in Paint

By Perry Hurt

***Thus the battle really is between traditional art and the new art, between old painting, and the new painting.***

—Edmond Duranty, 1876



By the first Impressionist exhibition in 1874 there had been two hundred years of government control of the arts in France through the French Academy, which perpetuated humanist artistic traditions established three hundred years earlier during the Renaissance, including the painter's palette of pigments had barely changed in four hundred years. It was time for a revolution.

Young painters including Claude Monet, Alfred Sisley, and Camille Pissarro shared frustration over the confining traditions of academic painting. Influenced by a few maverick painters that preceded them, and inspired by an unprecedented number of newly invented paint pigments, these artists invented a new style that we call 'Impressionism'.

The birth of modern science and the Industrial Revolution in 18<sup>th</sup> century Europe supplied an unprecedented expansion in the artist's palette. More than twenty intense yellow, green, blue, red, and orange pigments were invented between 1800 and 1870. The Impressionists took advantage of the new pigment's inherent chromatic and physical properties to forego the laborious techniques of traditional

academic painting for a quicker and more direct painting style. These innovations, and the new paint tube, helped the impressionists seize the flickering light, and pulsing life around them, abandoning the conservative historical and mythological studio products of academic painting.

In October, 2006 the North Carolina Museum of Art mounted a major international loan exhibition, *Monet in Normandy*, featuring 50 paintings by the great French impressionist master. In conjunction with this exhibition, the Museum's conservation and curatorial departments developed a focus exhibition called *Revolution in Paint*, which contrasts the paint and painting techniques of the impressionists with the traditional materials and techniques used by the established 19<sup>th</sup>-century French academic painters. *Revolution in Paint* is made possible by the generous support of SunCom Wireless, Inc.

Today the prismatic colors, impasto, and quick summary style of impressionist painting receives nearly universal praise, but when first exhibited in the 1870s the reaction of the public and many critics was quite the opposite. A comparison of the materials and painting techniques of the academic painters and the Impressionists will help to remind us of the radical and unconventional nature of a new school of painting that would survive the harsh criticism of its day and come to captivate a world audience.

"Some people burst out laughing at the sight of these things, but they just leave me heartsick. The self-declared artists style themselves the intransigents, the impressionists; they take canvas, paint, and brushes, throw some color on at random, and sign the result."

—Albert Wolff, 1876.

"The unhappy impressionist can protest that his sincerity is absolute...But the public and the critics condemn him....For them, only one fact pertains: the things that the impressionists put on their canvases do not correspond to those found on the canvases of previous painters. It is different, and so it is bad."

—Theodore Duret, 1878

## **Contents**

- 1. The French Academy and Early Academic Training**
- 2. Academic Painting Technique and the Traditional Palette**
- 3. New Science, New Paint**
- 4. Impressionism: The New Painting**
- 5. Revolution in Paint Storage**
- 6. Analyzing Monet's Pigments**
- 7. Bibliography**
- 8. Acknowledgments**

## The French Academy and Early 19<sup>th</sup> Century Academic Training

### The French Academy

"The first modern academies...enshrined the fundamental humanist beliefs that the human figure provided the key to the divine order and that knowledge of pure beauty could only be derived through the study of the ancient Greek and Roman statuary."

—William R. Johnston, 2000

The first academies were formed in Italy during the Renaissance. These early academies were more like clubs than schools, where artists would gather to hone their drawing skills. Renaissance artists such as Raphael, Da Vinci, and Michelangelo used their exceptional draftsmanship to create painting that was far more realistic than previous painting. Great drawing came to be much more than simply recording what was seen, it was a way to distill and modify

reality using the artist's intellect as well as facility. Following the example of ancient classical Greek and Roman sculpture the Old Masters focused on the human figure (Humanism), recreating it in a highly controlled reasoned manner, using the figure to express the most profound ideas and emotions. Within paintings drawing came to be seen as the true test of artistic genius, frequently overshadowing the paint itself.

"Drawing does not consist merely of line: drawing is also expression, the inner form, the plane, modeling. See what remains after that. Drawing includes three and a half quarters of the content of painting..."

—Jean-Auguste-Dominique Ingres, mid-19th century

The French Academy, created in 1648, was one of the earliest national academies to be formed outside of Italy. Influenced by the earlier Italian academies, the French Academy institutionalized both the artistic focus on the figure as well as drawing as the basis of all the visual arts. At one point it was even given a monopoly of life drawing where it was unlawful to draw from a live figure outside the Academy, even in an artist's private studio. Through the years the Academy went through many changes in both form and leadership, but tended to become ever more rigid and devoted to the antique and the Old Masters, at times slavishly following their example.

In 1664 Louis XIV brought the Academy under control of the government. Louis used the Academy to foster a French style of art that he preferred, but also to make



Adolphe-William Bouguereau  
(French 1825-1905)  
*L'Art et La Littérature*, 1867  
Oil on canvas  
Collection of the Arnot Art Museum,  
Museum Purchase, 1977



Raffaello Sanzio, called Raphael (Italian, 1483-1520)  
*St. Jerome Punishing the Heretic Sabianian*, 1503  
Oil on panel, 10 1/8 x 16 1/2 in.  
Purchased with funds from Mrs. Nancy Susan Reynolds, the Sarah Graham Kenan Foundation, Julius H. Weitzner, and the State of North Carolina, 65.21.1

political propaganda to reinforce his position. Artists had to fall in line with the Academy and the king's preferences if they expected to receive royal patronage and government commissions. Being a Royal Academician and receiving Government commissions resulted in higher prestige and visibility, in turn drawing other clientele and financial success. These practices continued under subsequent monarchs and revolutionary governments through the 19<sup>th</sup> century.

In time the Academy became an extraordinarily powerful institution that dominated nearly all aspects of a French artist's career. In the 17<sup>th</sup> century an unlimited number of artists could attain the level of Academician, many reaching that level in their twenties or thirties, an allowing a certain amount of diversity, even including women artists. By the 19<sup>th</sup> century the number of Academicians became limited to a small group who kept their status for life. This created an inherently older and more conservative body. The Academicians were the professors at the Academy's school, the Ecole des Beaux-Arts. Here the strict training regimen quelled individualism, turning out students steeped in tradition. By controlling training the Academy dictated style, perpetuating the status quo.

Practically the only way an artist could publicly show his work, find buyers and make a living, was through the government's nearly annual Salon exhibition. Almost every French artist, and many European artists, would submit art to this exhibition in hopes of official acceptance and awards, which raised their visibility and usually resulted in financial success. The juries for the Salon were dominated by Academicians, who rejected any work that they deemed sub-standard or outside their own ideas of what constituted art.

Ultimately all roads lead through the Academy for the French artist. The Academy dictated subject matter, style, and technique through out the artist's career. From training, to exhibition, to financial and critical success, Painters simply could not expect to succeed without working within the academic system and creating art that meet its expectations.

### **Academic Training**

"When you do a figure study, always have the antique in mind."

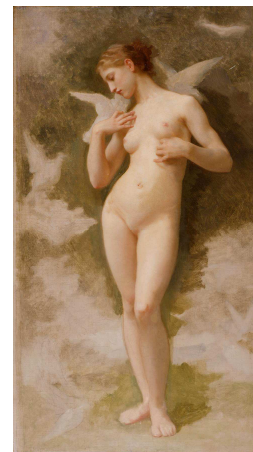
—Charles Gleyre to his student Claude Monet, c. 1862

In the Ecole des Beaux-Arts, the student's main activity was drawing. First they copied engravings after Old Master paintings, then plaster casts of ancient and renaissance sculpture. This work was meant to sharpen their skills of observation and facility with drawing media, but also to absorb the lessons of ancient artists.

"Our task is not to invent but to continue...following the examples of the masters."

—Jean-Auguste-Dominique Ingres, mid-nineteenth century

French artists idolized the Italian old masters. They aimed to absorb and then reassemble the work of the Renaissance artists, mixing it with their own talent to



*Aphrodite of Cyrene*,  
1st Century, Marble,  
H. 67 1/2 in. (171.5  
cm.)  
Purchased with  
funds from the  
State of North  
Carolina and from  
the North Carolina  
Art Society (Robert  
F. Phifer Bequest),  
1980 (80.9.1),  
NCMA

create original work. Study in Italy, with its immersion in ancient history and art, was seen as absolutely necessary to a serious artist. The most fortunate won the Prix de Rome, the annual prize for the most talented and skillful student of the Ecole des Beaux-Arts, which included a fellowship to the French Academy in Rome and practically guaranteed a successful career.

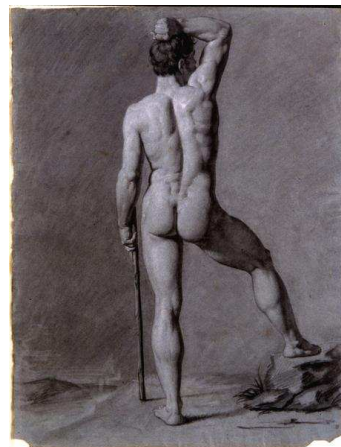
"...drawing is everything, the whole of art lies there."

—Jean Auguste-Dominique Ingres, mid 19<sup>th</sup> century



Adolphe-William Bouguereau, French, 1825-1905  
*Venus with Doves*  
circa 1879  
Oil on canvas  
32-1/8 x 18-3/8 in.  
Lent courtesy of the Ackland Art Museum, the University of North Carolina, Chapel Hill, Ackland Fund, 77.3.1

Eventually the Ecole student would move on to drawing live models. The model was always illuminated with a strong directional light, clearly delineating the figure in terms of light and dark forms. The students were expected to apply the example of classical sculpture and the old masters, accurately reproducing the pose but reshaping any individual characteristics to produce an idealized form. Students made so many of these figure drawings that they came to be called 'academies'. Ecole students also studied mythology and history, which was considered the most important subject matter for painting (followed by portraiture, with still life and landscape the lowliest of subjects).



Leon Cogniet, French 1794-1880  
*Male Nude from the Back*  
September 25, 1812  
Black and white chalk on blue paper  
23-3/4 x 18-1/4 in.  
Ackland Fund 86.40

"I have a long way to go before I can draw decently, and I haven't touched color yet, nor do I expect to until I can draw very well."

—Jean-Frédéric Bazille, c. 1862

"The material processes of painting are very easy and can be learnt in a week or so."

—Jean-Auguste-Dominique Ingres, mid 19<sup>th</sup> century



Jefferson David Chalfant, American 1856 – 1931  
*Bouguereau's Atelier at the Académie Julian, Paris, 1891*  
Oil on panel  
11 1/8 x 14 5/8 in.  
Fine Arts Museums of San Francisco  
Gift of Mr. And Mrs. John D. Rockefeller 3<sup>rd</sup>  
1979.7.26

Ecole painting students were not taught to paint. No time was given to paint materials or painting technique (until reforms in 1863). Students were expected to learn painting outside the Ecole in a private atelier of a master painter, frequently an Academician (which added to their influence as well as their income). But in fact most time in the atelier was also devoted to drawing the figure and preparing for competitions such as the Prix de Rome. The act of painting was perceived as a relatively mechanical application of paint, not much different from the

application of pencil or chalk. Once an artist had created a detailed drawing, painting was little more than a way to reproduce the drawing in a more solid medium and add decorative color. In fact bright paint color was purposely subdued so not to compete with qualities of drawing and design in the painting.

“Better gray than garishness.”

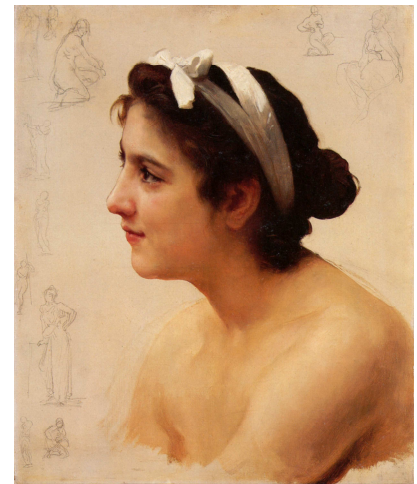
—Jean-Auguste-Dominique Ingres, mid 19<sup>th</sup> century

# Academic Painting Technique and the Traditional Palette

## Academic Painting Technique

Paint materials changed very little between the time of the Old Masters and the 19<sup>th</sup> c, as a result traditional approaches to painting were rarely challenged. The application of paint became relatively standardized by the 19<sup>th</sup> century, which explains the Ecole des Beaux-Arts' exclusion of its study. The academic painter's focus was almost entirely on drawing. Inspired by the idealized forms of classical sculpture, and influenced by the 'Age of Reason' and the sobriety of their time, early 19<sup>th</sup> century artists came to see perfection in craftsmanship as one of the strongest virtues their art could aspire to. Exacting drawing of figures and smooth flawless paint surfaces, with only the slightest hint of the artist's hand that created it, became a signifier of great art and artists, both to the artistic establishment and the viewing public.

A painting's creation was based on long and detailed planning. First came the '**esquisse**', a small loosely painted sketch that preserved the initial idea and established the basic composition. Each figure and detail within the composition was then studied and refined. An artist might sketch an outdoor scene, but most work took place in the studio where objects and live models could be posed as needed and studied at length. Poses would be modified, each object and drapery drawn precisely, and individual portrait made for each figure. This process might take weeks, months, even years as the artist refined his composition. Eventually a complete drawing was transferred to a canvas.



Adolphe-William Bouguereau,  
French, 1825-1905  
Study Of A Woman, for Offering To Love  
Private collection

The application of paint was meant to make the artist's imaginary composition as realistic as possible. Academic painters strove for what we might call 'photographic realism'. In fact photography was born in France in the early 19<sup>th</sup> century and quickly became a tool for the painter. They wished their paintings to be extremely solid in appearance. This generally necessitated several layers of paint to totally cover the canvas and abolish any detail that would destroy the illusion, such as bare white gesso. The standard academic approach to painting required three basic layers of paint.

The first layer of paint was a monochrome reddish brown color called '**le sauce**' (the gravy). The sauce was painted on quickly and freely over the whole surface to establish the composition in contrasts of light and dark. Subsequent paint layers accentuated these tonal contrasts, or chiaroscuro, creating a sense of depth and sculptural relief.

The next layer was called the '**ébauche**', which established the local color of objects. This stage of painting is sometimes referred to as 'dead coloring' because the artists generally used opaque and inexpensive pigments such as earth tones, white, and black. Although not as loosely applied as the sauce, ébauche paint was applied fairly broadly with little or no detail. During this stage some areas would be painted with a solid opaque tone in preparation for thin glazes of paint that would be applied in the next stage. This was often necessary for strongly colored areas, particularly greens,

and dark reds where the only available pigments were too transparent to stand on their own (i.e. verdigris, rose madder)

The *ébauche* layer was then allowed to dry thoroughly. All instances of raised paint such as impasto or brush marking would be scraped smooth.

Then came the third layer or '**second painting**', another complete layer of paint, the second in local color. Thin glazes of paint were applied, modifying and finishing each area in greater detail. Varnish, oil, and other special mediums were mixed into the paint to make it more fluid. This helped the paint to level as it dried, reducing brush marking. The highlights were applied last with slightly raised impasto to give a sense of immediacy to the work.

An academic painting was carried to a very high degree of finish. No white ground was left showing. Tonal transitions in the flesh tones were made as seamless as possible. Varnish was often applied between paint layers, as well as a final surface coating, helping to insure a smooth surface. A painting constructed in this fashion routinely took several months or even years from conception to the final varnish. These techniques allowed the academic artist to transform an idea into crystal clear reality. The work was created through extraordinary skill and control, but ultimately it was absolutely calculated and artificial in nature. Any spontaneity that might have been present in the *esquisse* rarely survived to the final finished painting. This approach was ideally suited to turning the historical and mythological inventions of the artist's mind into an illusion of reality, a mixture of the artist's skill and imagination with the Old Master traditions favored by the Academy.

### The Traditional Palette

The 19<sup>th</sup> century French painter's palette of pigments was a strong link with the past. It was practically identical to that of the Old Masters. It had taken thousands of years for mankind to assemble these colored materials for paint, almost all found before the advent of oil painting in the 15<sup>th</sup> century. Only two or three significant pigments had been discovered in the three hundred years between the Renaissance and the 19<sup>th</sup> century.



Detail  
Attributed to Michiel van Musscher  
Dutch (1645 – 1705)  
*Allegorical Portrait of an Artist*  
About 1680-85  
Gift of Armand and Victor Hammer, 1957  
NCMA

For oil painting there were approximately thirty pigments available at the beginning of the 19<sup>th</sup> century. About half of these were seldom used because of their expense, toxicity, propensity to fade, chemical instability, or other problems.

Painters were left with approximately fifteen pigments that were relatively reliable and useful. This traditional palette was weak in many areas. For instance the yellows were quite pale and dull. Only Indian yellow is fairly intense, but it was transparent and was subject to fading. Also there was no trustworthy green pigment. Verdigris, a bluish green, was used on occasion but was chemically unstable and frequently turned brown. As a result almost all green paint was actually a mixture of blue and yellow pigments, which of course suffered from a lack of a strong yellow pigment.

In practically every depiction of the palette from the 16<sup>th</sup> to the early 19<sup>th</sup> centuries, the paint has been laid out by tone, from light to dark. This illustrates the reliance on tonal contrast to create the illusion of three dimensional form through centuries of painters. The same tonal contrast that was established with drawing using chalk or graphite.



### **Simulated Traditional Palette**

2006 re-creation of early 1800s palette

Pigment with date of invention or earliest known use as artists' paint

1. Lead white, ancient Greece
2. Naples yellow\*, ancient Egypt
3. Indian yellow, 16<sup>th</sup> century
4. Yellow ochre, prehistoric
5. Red ochre, prehistoric
6. Vermilion, medieval
7. Rose madder, ancient Egypt
8. Carmine\*, medieval
9. Burnt sienna, Early Renaissance
10. Brown madder\*, 18<sup>th</sup> century
11. Bitumen, medieval
12. Cassel earth, 16<sup>th</sup> century
13. Ivory black, prehistoric
14. Prussian blue, 1710
15. Ultramarine blue, natural, medieval

\*Sample is a modern approximation of the original pigment.

## New Science, New Paint

France in the eighteenth century was in the forefront of the Age of Enlightenment, a time when superstition was being replaced by the application of reason. At the same time the machine age was sweeping Europe, what we now call the Industrial Revolution. Nearly every aspect of life of was affected. Rational thinking and industrial application gave rise to possibly the most important event in the history of science, the birth of modern chemistry. There were major leaps in the understanding of chemical interaction and the identification of basic elements. Previous to the year 1700 only fifteen elements were known. Between 1700 and 1850 forty new elements were discovered!



Crocoite, a natural chrome mineral.  
Photo by Roger Weller  
Cochise College, Arizona

The new chemical scientists were hired by industrial businesses such as textile manufacturers to find new and better ways to add color to their products. Brightly colored commodities sold better and for higher prices in the burgeoning market of cheap industrially manufactured goods. New substances were quickly investigated for their potential as pigments. Between 1800 and 1870 more than twenty intense yellow, green, blue, red, and orange pigments were invented, many based on newly discovered elements such as chrome, cadmium, and cobalt. Each new pigment was quickly picked up by artists' colourmen, turned into paint, and sold to artists. New materials often give an artist an opportunity for innovation, but this expansion in the number and variety of pigments was unprecedented in the history of art. An equally dramatic shift in the history of painting was bound to happen.

As a rule the new pigments were more opaque and had greater tinting strength than traditional pigments. While some new pigments were only marginally better than similar traditional hues, others represented dramatic improvements, or were completely without precedent. Natural ultramarine blue was unrivaled in six hundred years of art in terms of beauty and chemical stability. It was also enormously expensive, which limited its use. The new chemically identical 'French' ultramarine was dramatically cheaper, a tenth the cost, and could now be afforded by even the poorest painter. Chrome yellow was the first rich opaque yellow that wasn't rare, expensive, highly toxic, or faded quickly in light. There had never been a strong chemically stable green. Now there were three: chrome oxide green, emerald green, and viridian.

### An Impressionist Palette

"Since the appearance of impressionism, the official salons [exhibitions], which used to be brown, have become blue, green, and red."

—Claude Monet, c. 1915



### **Simulated Impressionist's Palette**

2006 re-creation, based on Monet's palette of the 1870s

Pigment with date of invention or earliest known use as artists' paint

1. Lead white, ancient Greece
2. Chrome yellow\*, 1820
3. Vermilion, medieval
4. Red ochre, prehistoric
5. Alizarin crimson (synthetic rose madder), 1868
6. French ultramarine, 1826
7. Cobalt blue, 1802
8. Viridian, 1838
9. Emerald green\*, 1814
10. Ivory black, prehistoric

\*Sample is a modern approximation of the original pigment.

## Impressionism: The New Painting

“The Impressionist sees and renders nature as it is – that is, wholly in the vibration of color. No drawing, light, modeling, perspective, or chiaroscuro, none of those childish classification.”

—Jules Laforgue, 1883

The artists that were to become the founding impressionists expected to pursue art within the academic system, they had little choice. Claude Monet, Alfred Sisley, Renoir, and Bazille meet in the training atelier of Charles Gleyre. Gleyre was an academic painter of note, and ran one of the most popular, if more liberal ateliers in Paris. They endured long hours of drawing live models and critiques by Gleyre, looking forward to the day they were allowed to pick up a brush to paint. It was during their first years together in the early 1860's that the four young artists, frustrated by their rigid training, the constraints of academic tradition, and stale work of popular artists of their day, slowly started to create their new painting style. The impressionists found their inspiration to break with academic painting in the work of a few preceding non-conformist artists: including Eugène Delacroix, François Millet, Eugène Boudin, Gustave Courbet, Camille Corot, and Édouard Manet among others. These artists influenced the Impressionists in many different ways. Some focused on landscape and contemporary images of their own day as subject matter. Others left the studio to paint outdoors almost exclusively, while others used strong color and expressive brushwork. Almost all of these artists used a more direct technique of paint application that depended less on the formulaic building of paint layers, but for the most part their palette was still dominated by traditional pigments, particularly brown. Rarely did they use the modern pigments that were being invented during their life time.

But it was the new pigments that were the catalyst that created an altogether different way of painting. Of course there were many new colors, expanding the painter's palette. But it was how the impressionists used the new pigments, how the pigments allowed the impressionists to work, that changed the history of painting. Not only did the new pigments allow for much quicker painting, they also came with a new understanding of the nature of color and light, totally changing the painters' thoughts of what they were representing on their canvas.

Most of the new pigments were quite opaque. A few such as viridian green and alizarin crimson on the other hand were relatively transparent, but their high tinting strength meant that they could be made opaque by mixing with lead white and still retain a strong color. Paintings could be executed much more quickly using opaque paint, rather than the layering of thin paint typical of academic technique. The impressionists could paint a scene in a very short time span, a matter of days or weeks, rather than months or years. They could more easily capture scenes of their own day, a time when societies' focus was changing from an obsession with the past to the quickly changing present. A time that included newly invented steam powered ships, trains, and factories.



Alfred Sisley  
French (1839-1899)  
*Apple Trees in Flower*, 1880  
Oil on canvas  
Gift of Walter P. Chrysler, Jr.  
Chrysler Museum of Art, Norfolk, VA; Gift of Walter  
P. Chrysler, Jr. 77.412

The birth of the machine age and the industrialization of Europe had supplied the new pigments, but it also gave the world a new understanding of color. Early industrial color chemists such as Eugene Chevreul (1786-1889) experimented and wrote extensively on the nature of light and color. Chevreul was the first to explain the phenomenon of simultaneous contrast or 'complementary colors', where a color appears brighter and stronger when placed next to its complimentary color. With primary and secondary colors this occurs with the combinations of red-green, yellow-purple, and blue-orange. While painters had instinctively used complimentary colors in their work for thousands of years, it was always limited by the available pigments. The medieval painter had a strong red in vermilion, but there was no green pigment even remotely as strong to pair with the red. The new pigments supplied strong primary and secondary colors, particularly yellows, greens, and even purple, giving the impressionists a very balanced palette.

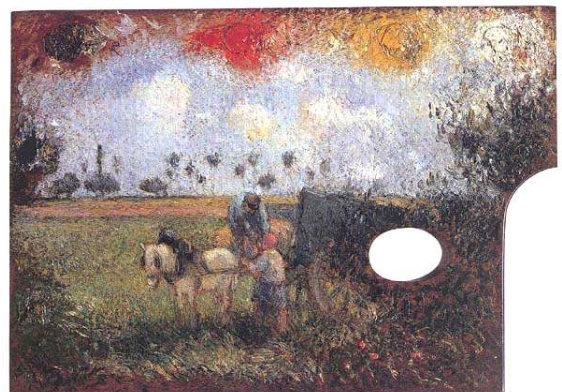
The chemists also extended the work of Isaac Newton (1642-1727), who proved that natural white light contained all other colors of light. He demonstrated this by passing sunlight through a prism, splitting it into all the colors of the rainbow. These ideas lead the impressionists to fundamentally change their approach to painting.

Traditional painters focused on the development of form in terms of light and dark, a technique called chiaroscuro. Models in the studio were lit with a single directional light source that accentuated the figure in strong contrasts of light and shadow. The artists built an illusion of three dimensions through carefully drawing the hard edged contours of the model and carefully shading the contrasting forms. Through meticulous tonal modeling and the application of formal pictorial devices such as perspective they were able to turn the inventions of their minds into concrete reality on their canvas.

"Replace tonal modeling by the study of colors."  
—Paul Cézanne, 1874

As the writings of the color chemists became more widely known in the second half of the nineteenth century, progressive artists increasingly considered artwork born of the studio, and its dependence on artificially controlled light, as "false" and hopelessly mired in the past. The impressionists sought the 'truth' by working outside in nature light. Not only did they find subject matter in the landscapes and everyday life around them, light became a subject in itself. The impressionist came to see the world as flicking light and color, a jumble of prismatic light reflected to our eye. The pigments on their palette were not just colors; they were the ingredients of light. With new pigments filling the gaps in the old traditional palette, the

impressionists had the primary building blocks of light in the form of physical paint. They abandoned the use of strong contrasts of light and dark, choosing instead to juxtapose color to distinguish forms. Mixing nearly all their colors with white



Camille Pissarro  
French, 1830- 1903  
*The Artist's Palette with a Landscape*  
c. 1878  
Oil on panel (artist's palette)  
9 1/2 x 13 5/8 in  
Sterling and Francine Clark Art Institute,  
Williamstown, Massachusetts  
1955.827

gave their paintings a lighter tone overall, infusing their paintings with a sense of light.

While the number and variety of pigments available to the impressionists were greater than any previous time in the history of art, the impressionists actually used fewer pigments for any one painting than any of their predecessors. Monet's paintings in the late 1860's, before impressionism and still influenced by academic painting, contain as many as 15 pigments in one painting, half of them traditional pigments. A decade later, at the height of pure impressionism, the Impressionists' paintings generally contain no more than 8 or 10 pigments, all but one or two are new nineteenth century pigments. Yet, with the reduction in the number of pigments used, the paintings actually appear more colorful! This is clearly illustrated by *The Artist's Palette with a Landscape*, painted by Pissarro in 1879. Here Pissarro shows us that he can paint a fully colored landscape, with only six pigments! Arranged along the left and top edges are: emerald green, French ultramarine blue, red lake (possibly the recently invented alizarin crimson), vermilion, chrome or zinc yellow, and lead white. Lead white, vermilion, and possibly the red lake are the only traditional pigments. Pissarro has used his understanding of the prismatic nature of white light and color mixing of primary and secondary colors to create any color he needs to reproduce. The six colors constitute a very balanced representation of the color wheel, used together their strong tinting strength and opacity made it possible to create almost any desired color simply by mixing.

The impressionists abandoned drawing and the hard edged depiction of objects. They were no longer interested in the underlying structure of objects. Meticulous drawing was of no use. It simply took too long to record a moment of glittering light. Figures became mere blobs of paint. Clarity and finish were replaced with an intentional lack of detail. Patches of white ground were left exposed, becoming a functioning part of the image—unheard of in academic painting.

"I never draw except with brush and paint."

—Claude Monet

The impressionist use of broken brush work and pronounced paint texture was an integral part of their technique. The rough surfaces of their paintings reflect light unevenly, adding to the illusion of shifting transient light. Having dropped many of the formal academic devices in favor of seemingly random compositions, the texture also helped hold the image together visually.

Once again changes in the manufacture of paint itself was the catalyst for this new technique. For century's oil paint was typically made using linseed oil, which tends to level during drying, reducing texture. During the eighteenth and nineteenth centuries the manufacture of paint switched from the painters themselves to the artist's colorman, a new tradesman who made and sold paint to artists. The shelf life of paint became very important. Slower-drying poppy oil came to replace linseed oil, making it more likely that paint would remain usable over the unpredictable time period between the colorman's manufacture, sale, and use by the artist. But this had an unintended consequence. Poppy oil paints tend to retain texture as they dry.

Traditionally paint tended to be made quite stiff with a minimum of oil medium. It was necessary for the artist to add more oil to make the paint usable. Academic painters continued to add extra medium to their poppy oil paints to create smooth paint surfaces, which spoke to them of control, precision, and good craftsmanship. First the Romantic school painters such as Delacroix, then the impressionists used

the natural tendencies of the paint to create textured surfaces. Because of their innovations, paint impasto came to be seen as an immediate indication of modernity in a painting. Smooth surfaces became associated with conservative traditionalism.

Working outdoors directly from nature, the impressionists used their new pigments and techniques to capture crisp, scintillating qualities of light rarely seen in painting before their time. But their paintings were nearly the antithesis of the popular painting of their day, the definition of 'cutting edge'. The public and many critics, accustomed to the detail and polish of academic painting, simply couldn't understand this drastic and sudden change. They criticized impressionism's quick summary technique as nothing more than an *ébauche*, as if the impressionists had stopped halfway into creating their painting. To them impressionist paintings showed little more than a lack skill and the imitative to finish what was begun. They didn't realize that the goals of the painter and painting itself had changed.

## Revolution in Paint Storage

“Without colors in tubes, there would be no Cezanne, no Monet, no Pissaro, and no Impressionism.”

—Pierre Auguste Renoir

Since the advent of oil painting in the 15<sup>th</sup> century, the storage of prepared paint has been an issue for painters. Oil paint becomes unusable in a few days if left out in the open air. Particularly before the 19<sup>th</sup> century paint was expensive, something that was not to be wasted. Whether stored in pottery cups tightly sealed with oilskin, or submerged under water in seashells, the shelf life of oil paint was very short.

Academic painting technique required that each paint layer dry before proceeding with the next. Any excess paint on the palette would dry out and harden long before it could be used for the next layer. The artist would prepare his palette with only the colors that were needed to complete a day's work. This usually meant painting one similarly colored area at a time: sky, trees, drapery, each with a different palette of colors. As a result most paintings were developed piece by piece. A figure would be nearly complete while its drapery would hardly be started. A blue sky would be finished before any green was placed on the trees. It was fool hardy to have all the paint one needed to complete a painting ready prepared and on hand, particularly for a large painting. It would spoil before it could be used. Each day the painter, or a studio assistant, would grind together oil and pigments to make the paint that was to be used for that day's painting. Only a few of the dozen or so different colors the painter might need could be ready to use at any one time. Painters made their own paint right up into the eighteenth and nineteenth centuries largely because of this lack of adequate storage technology. It was only with improved storage containers that 'store bought' paint became possible.

“May I remind M. Etienne [colourman Etienne Haro] that he promised to put aside for me the bladders of Prussian brown that he recently made? But I would like only one bladder at a time in order to avoid it spurting out.”

—Eugene Delacroix, 1854

The pig's bladder was the best available paint storage container during the 18<sup>th</sup> and early 19<sup>th</sup> century. It was particularly popular with the new artists' 'colourman', a vender who made and sold paint and other painting equipment to professional painters as well as the rapidly growing army of amateur painters who didn't care to grind their own paint. The bladder afforded the best alternative to package, transport, and store small quantities of paint for short periods of time. But bladders were famously messy, often bursting unexpectedly. Any handling or moving had to be kept at a minimum. The bladder was opened by piercing with an ivory tack, but it could not be effectively resealed. The remaining contents leaked out or spoiled in a short time. Paint would only last a few months under the best of conditions before it hardened. Bladders were much too



Paint bladder  
Nineteenth century  
Harvard Art Museums

undependable and messy to attempt to use them outside the studio. Very few artists attempted to paint out doors with them.

## The Tube

In 1841, a South Carolina painter named John G. Rand patented a new device for paint storage, the collapsible metal tube. He invented the tube out of frustration, to often seeing his bladder stored paint spoiled before it could be used. The collapsible metal tube was a vast improvement in paint storage. The metal was impermeable, so the paint couldn't dry out or harden. The tube could be opened and resealed numerous times, so there was very little waste. Paint could now be stored almost indefinitely. The tube would of course go on to greater fame as a container for toothpaste and other products. The convenience of the new paint tube is captured by this mid-nineteenth-century advertising label:



"REEVES & SONS' COLLAPSIBLE AIR-TIGHT METALLIC COLOUR TUBES. A new invention for containing Oil Colours, which supersedes Bladders, and prevents all waste, dirtiness, and smell, and will preserve the Colour any length of time in any climate."

Paint tube  
Lefranc & Cie brand  
Late nineteenth century  
Chrysler Museum of Art, Norfolk,  
VA; Gift of Edith Ballinger Price

The tube offered almost indefinite paint storage; there was no need to limit the amount of paint on hand. Now the painter could have all the paint he needed to complete a painting at his immediate disposal without fear it would spoil before it could be used. He was no longer limited to working on one small similarly colored area of a painting at a time. Now the painter could work anywhere on the painting's surface at anytime, developing the whole painting at once. This was absolutely crucial with the impressionists. They needed to work very quickly to capture fleeting effects of light and weather. This required an intuitive immediate response which could not be limited to one small part of a larger composition.

"Don't paint bit by bit, but paint everything at once by placing tones everywhere."  
—Camille Pissarro

Tube paints were eminently portable, allowing painters to take their paints anywhere they wished to set up their easel. Earlier painters were limited to making studies with dry drawing materials, or watercolors, but rarely with oil paints. Making a finished oil painting outside the studio was unheard of. For the first time in history the paint tube made it practical to produce a finished painting on-site, whether in the gardens of Giverny or standing on the cliffs along the Norman coast.

"My studio! But I never have had one, and personally I don't understand why anybody would want to shut themselves up in some room. Maybe for drawing, sure; but not for painting."

—Claude Monet, 1880

The paint tube in the Revolution exhibition was made by Lefranc, a brand familiar to most 19th century French painters. Lefranc's roots can be traced to 1720 when the French painter Jean Simeon Chardin asked his spice and pigment merchant, a Lefranc family ancestor, to make his paints. William Bouguereau wrote, "I am

pleased to have only good to say about the colors made by Messieurs Lefranc and Cie." The impressionists did not care for machine made paint such as Lefranc's, which had suffered numerous problems in the early 19th century shortly after its invention. They were more confident in the quality of hand ground paints, which they bought in tubes from independent colourmen. This tube's pigment, cadmium yellow, was invented in 1846. It became a favorite of the impressionists for its bright hue, strong tint, and opaque nature.

## Analyzing Monet's Pigments

"In short I use flake white, cadmium yellow, vermilion, red lake deep, cobalt blue, viridian green, and that's all." – Claude Monet, c. 1905

The exhibition *Revolution in Paint* is based on a simple premise: a radical change in artist's pigments during the nineteenth century enabled a revolution in painting. A different palette of paint made it physically possible for the impressionists to paint differently from their predecessors. To make this distinction it's extremely important to know who was using what pigments and when.

Monet's blunt statement doesn't appear to leave any doubt as to his choice of pigments. He's made our research very easy. But can we take Monet's words at face value? Does it tell the whole story of the impressionist's revolutionary painting? If only it were so simple.

A quick look at Monet's statement shows how misleading it can be. Monet and the impressionists burst on the scene in 1874. Is Monet saying these are the pigments he used in the early 1870's, or is this what he was using in 1905, or did he use the same pigments for thirty years. The term "red lake deep" couldn't be more ambiguous. A red lake is a dark red wine colored pigment. It could be made from rose madder root or cochineal beetles, both of which had been used for hundreds of years, part of the traditional palette. Or it could be a modern synthetic such as mauveine or alizarin crimson, invented in the middle of the nineteenth century. In fact there were as many as 22 variations of red lake available in the late nineteenth century. To make things even more confusing, artists didn't necessarily know what they were using. Labels often didn't accurately describe the ingredients of a paint tube. What do you suppose the pigment would be in 'geranium lake', geraniums? As you can see, knowing exactly which pigments the impressionists used to make their revolutionary paintings turns out to be quite complicated.

*Revolution* was created as a focus exhibition to compliment the major exhibition *Monet in Normandy*. Naturally Monet was of particular interest during our research. A great deal has been written about Monet and his extraordinary use of color. The blues, the greens, the violets, his colors are all so vibrant. Legions have tried to duplicate his effects. But to paraphrase an old saying, you can't judge a pigment by its color. Although some knowledge of pigment history and a good eye can narrow down the choices, you have to go much further to identify a pigment with any certainty. The information used to create *Revolution in Paint* came from many sources: direct quotes, artist's notebooks, eye witness accounts, colormen catalogs, and contemporary how-to books. But ultimately only modern scientific analysis can pinpoint the pigments on any individual painting.

One particularly good published study of Monet's pigment choice is *Art in the Making: Impressionism*. The National Gallery of London's conservation scientists analyzed



Claude Monet (French, 1840-1926)  
*The Cliff, Etretat, Sunset*, 1883  
Oil on canvas, 21 3/4 x 31 3/4 in. (55.2 x 80.6 cm.)  
Purchased with funds from the State of North Carolina, 67.24.1

■ Blue paint sample site, not to scale

many of their impressionist paintings in preparation for an exhibition in 1990. Their work shows that within just five Monet paintings nineteen different pigments were used, far more than his statement in 1905 suggested. These five paintings were executed between 1869 and 1879, bridging the date of impressionism's birth and show a striking change in Monet's palette. Monet used some fifteen pigments in the earliest painting, half of which are common to the traditional palette. The 1879 painting uses only eight pigments, all but one or two new to the nineteenth century, but even this painting's pigments are different from Monet's 1905 list.

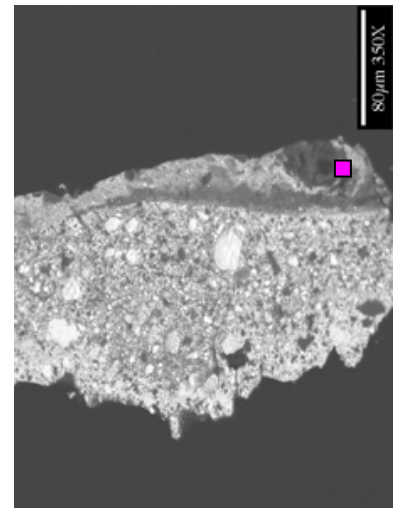
The National Gallery's results inspired us to analysis one of our own Monet paintings at the North Carolina Museum of Art, to see how it might compare. Our experience in studying the pigments in the painting *The Cliff, Etretat, Sunset* serves to show the difficulty of such an undertaking. First of all scientific analysis is expensive. Conservation scientists charge as much as \$500 to \$1000 to investigate one small paint sample. A full study of the painting would have cost half of the *Revolution* exhibition budget, which wasn't an option. Fortunately the analysis was undertaken by Dr. Peter Bush, Director of the South Campus Instrumentation Center (SCIC), James Hamm, Professor of Painting Conservation, and Dr. Gregory D. Smith, Andrew W. Mellon Professor in Conservation Science. All three are employees of the State University of New York at Buffalo (SUNY). These gentlemen generously donated their time, expertise, and the use of their analytical equipment, greatly reducing the cost of this undertaking. The project was coordinated by Erin Kelly, conservation intern at the NCMA from SUNY, who also compiled and helped interpret the data.



Dr. Peter Bush, James Hamm, Dr. Gregory D. Smith, all of the State University of New York at Buffalo.

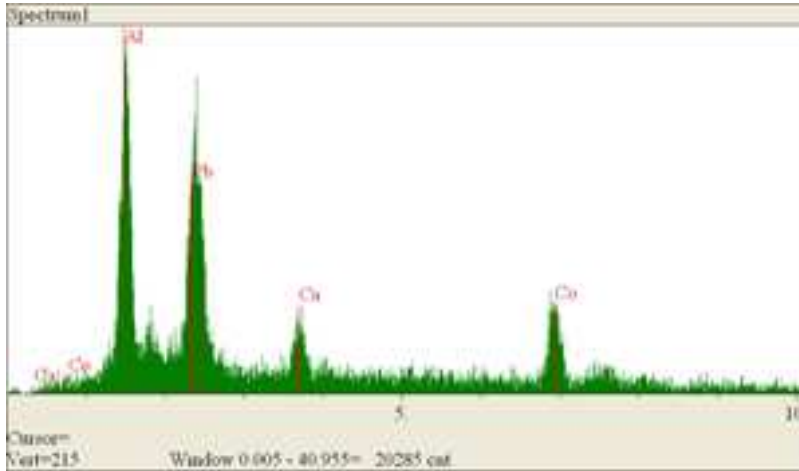
Our analysis required that samples be taken from the painting. Extremely small specks of paint, smaller than pinheads, were taken from the outside edges of *Etretat*. The samples were mounted to clearly show the layers of paint including the white ground layer.

The cross-sections were then examined with a scanning electron microscope (SEM), which helps to distinguish between individual pigment particles. The shape and size of particles can help to identify pigments, but is not definitive. SEM imaging is necessary to map the sample in preparation for energy dispersive x-ray spectroscopy analysis (EDX), which can identify elements within small groups of particles. The presence of a particular element can be very strong evidence of certain pigments. The figure shows the EDX spectrum of site BB2 within the larger cross-section of blue paint. Peaks in the spectrum shows that cobalt (Co) and aluminum (Al) are present, suggesting the presence of cobalt blue pigment. The same spectrum shows the presence of lead (Pb), probably from the mixture of lead white paint into



SEM image of blue paint sample.  
 ■ BB2 EDX sample site  
 ■ BB3 EDX sample site

the blue, a common impressionist technique. But to complicate matters, site BB3, a hair's breadth away, contains arsenic and copper, elements used in green pigments such as Scheele's green or Emerald green. Looking at the painting with the naked eye, one sees only a blue paint stroke. But the analysis suggests that Monet actually mixed white, green, and blue pigments to create what looks like a simple blue color.



EDX spectrum for sample BB2

We can also see that Monet used yellow in painting *Etretat*. Unfortunately, SEM-EDX analysis didn't show an element that we can associate with an inorganic yellow pigment: no chrome for Chrome yellow, no cobalt for aureolin, and no cadmium for cadmium yellow. This illustrates another difficulty in pigment analysis; no one test can reliably identify all possible pigments.

SEM-EDX is an excellent tool for identifying inorganic pigments that contain a rare or individualistic element. We were able to identify white lead, vermilion, cobalt blue, ultramarine blue, Scheele's or Emerald green, and possibly manganese violet. But what if a pigment is composed of common elements: carbon, hydrogen, and oxygen? This is the case with organic pigments. Organic pigments of many different colors were historically derived from animal and plant sources, but were also first artificially synthesized in nineteenth century chemistry labs. Monet's yellow in *Etretat* is most likely an organic pigment, but which one? There were many different organic yellows in use at the time, both traditional and new.

Identification of Monet's yellow, as well as the organic red lakes mentioned earlier, would require a battery of tests using different equipment. Unfortunately this was beyond the scope of our project and resources. Publishable results, such as the National Gallery's, in fact require numerous types of testing. Positive identification by one type of analysis is usually confirmed by a second type of analysis to be certain of the result. Ultimately, the exact identification of pigments for any one painting requires a great deal of equipment, expertise, time, and financial resources.

Even when all the necessary resources come together mysteries remain. There are numerous complicating factors which interfere with even the best analysis. Is the painting actually by the artist? Fakes, forgeries, and misattributions are common with artworks. Does the paint sample really represent the artist's work? During the long life of an artwork the original materials can become adulterated by the aging process, restoration, or even reworked by the artist at a later date. In some cases our technology falls short. Distinguishing between the many red lakes is particularly

difficult. This leads us back to Monet's 1905 statement. The positive identification of an artist's materials doesn't stand on any one piece of evidence. While scientific analysis appears to throw some doubt on Monet's own words, it's only the combination of all available evidence that can bring us close to the truth.

## **Bibliography**

*Art In the Making: Impressionism*, by Bomford, Kirby, Leighton, and Roy, 1990, The National Gallery, London with Yale University Press

*Art of Impressionism: Painting Technique and the Making of Modernity*, by Anthea Callen, 2001, Yale University Press

*The Art of Painting in Oil and in Fresco*, M.J.F.L. Merimee, 1839, Whittaker & Co., London

*Artist's Pigments: A Handbook of Their History and Characteristics*, Vol. 1, 2, and 3, 1986, 1993, 1997, National Gallery of Art

*Artists on Art*, Goldwater and Treves, Pantheon Books, 1966

*Bouguereau*, by Fronia E. Wissman, 1996, Pomegranate

*Bright Earth: Art and the Invention of Color*, by Philip Ball, 2003, University of Chicago Press

*The Chrysler Museum: Handbook of the European and American Collections*, Jefferson C. Harrison, The Chrysler Museum, 1991

*Color*, by Victoria Finlay, 2003, Ballantine Books

*Colors from the Earth; The Artists' Guide to Collecting, Preparing, and Using Them*, by Anne Wall Thomas, 1980, Van Nostrand Reinhold company

*Colors; The Story of Dyes and Pigments*, by Francois Delamare and Bernard Guineau, 1999, Discoveries, Harry N. Abrams

*Color and Culture, Practice and Meaning from Antiquity to Abstraction*, by John Gage, 1999, University of California Press

*French Salon Paintings from Southern Collections*, Eric M. Zafran, The High Museum of Art, 1982

*Handbook of Young Artists and Amateurs in Oil Painting*, a compilation of work by Merimee, De Montabert, and others by an anonymous American artist, 1849, New York: John Wiley, London

*In the Studio: Art and Art-Making in the Nineteenth-Century France*, Bailey, Strong, and Wood, Ackland Art Museum, The University of North Carolina at Chapel Hill, 2002

*The Judgment of Paris: Manet, Meissonier and the Birth of Impressionism*, by Ross King, 2006, Walker & Company

*Mauve*, by Simon Garfield, 2002, W. W. Norton & Company. About William Perkins, inventor, 1850's

*The New Painting: Impressionism 1874-1886*, The Fine Art Museums of San Francisco, 1986

*Techniques of the Impressionists*, by Anthea Callen, 1982, Chartwell Books, Inc.

*William Bouguereau 1825 - 1905*, 1984, The Montreal Museum of Fine Arts

*Nineteenth-Century Art: From Romanticism to Art Nouveau*, William R. Johnston, The Walters Art Gallery, 2000

*North Carolina Museum of Art: Handbook of the Collection*, North Carolina Museum of Art, 1998

## Acknowledgments

Many people contributed to the development of *Revolution in Paint*, the *Revolution* web exhibition, and this supplement. I'd like to thank everyone for their work and personally supporting me on this project including the staff of the NCMA, and my wife Nancy.

Thank you to the presenting sponsor SunCom Wireless.

### **North Carolina Museum of Art**

Nancy Allred, Conservation Office Manager  
Bill Brown, Chief Conservator  
John Coffey, Deputy Director of Art  
Marcia Erickson, Assistant Registrar  
Carrie Hedrick, Head Registrar  
Erin Kelly, Conservation Intern  
Karen Kelly, Editor  
Karen Klein, Director of Corporate Relations  
Natalia Lonchyna, Librarian  
Holland Macdonald, Head of Publications  
Karen Malinofski, Head of Photography  
Jane McGarry, Head of Exhibition Design  
Noelle Ocon, Associate Conservator  
Tiara Paris, Exhibitions Manager  
David Steel, Curator of European Art  
Ashley Weinard, Associate Director of Education

### **Lending Institutions**

Lynne & Mark Hammerschlag, owners of  
the Hammerschlag collection  
Jeff Harrison, Chief Curator, Chrysler  
Museum of Art  
Narayan Khandekar, Conservation  
Scientist, Harvard Art Museum  
Mark Lewis, Paintings Conservator, Chrysler  
Museum of Art  
John D. O'Hern, Executive Director and Curator,  
Arnot Art Museum  
Timothy A. Riggs, Curator of Collections,  
Ackland Art Museum

### **The State University of New York at Buffalo**

Dr. Peter Bush, Director of the South Campus  
Instrumentation Center (SCIC)  
James Hamm, Professor of Painting  
Conservation  
Dr. Gregory D. Smith, Andrew W. Mellon  
Professor in Conservation Science.

### **And those who were particularly generous with their research and expertise**

Anthea Callen, Emeritus Professor of Visual  
Culture, The University of Nottingham  
Ann Hoenigswald, Senior Conservator of  
Paintings, National Gallery of Art  
Eik Kahng, Curator, The Walters Art Museum  
Jo Kirby, Conservation Scientist,  
The National Gallery, London  
Dominique Sennelier, Sennelier Paints and  
Fine Art Materials, Paris