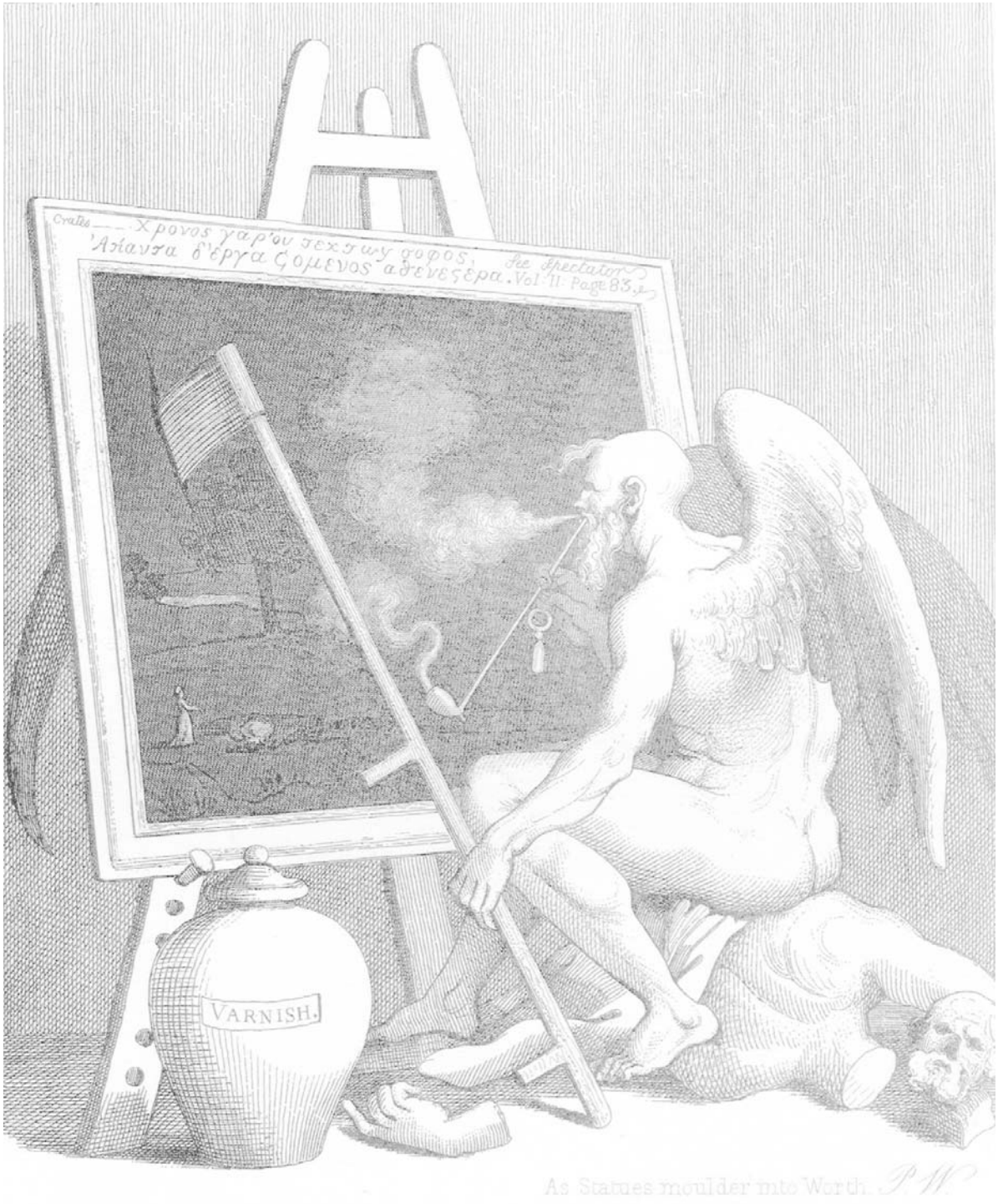


William Hogarth, *Time Smoking a Picture,* Etching and Mezzotint, 1761

Introduction

To truly understand and appreciate a work of art, it is important to have a basic knowledge of materials and techniques employed by the artist. The effect that the condition and previous conservation treatment has on a painting must also be considered, because of the large impact it may have on the appearance of that work. This brochure will help define the materials and techniques used in painting and the procedures that may ensue during a conservation treatment. Because of the scope of the collection at the North Carolina Museum of Art, the information presented below focuses on European painting from the 14th century to the 19th century.

Materials

The history of painting has included the use of many different materials. The basic definition of a painting: a pigment mixed in a medium and applied to a support. An easel painting typically has at least four basic layers: support, ground, paint, and varnish.

Supports for Easel Paintings

- Wood – usually oak for Dutch, Flemish and German paintings and poplar for Italian paintings, also walnut and mahogany
- Canvas – usually linen, also hemp, jute, burlap, and cotton
- Metal – copper, also tin, zinc and silver

Wood was the most common support used for paintings from medieval times through the Renaissance. However, as the role that art played in society changed, paintings became larger in scale, and as a result the portability and flexibility of a canvas support gained preference over wood. Paintings on metal supports were usually small-scale works, common in Dutch and Flemish painting. Oak was favored by the Northern Artists and the systematic cataloging of oak tree rings (dendrochronology) has become a source for the dating of the panels.

Grounds for Easel Paintings

- Gesso – mixed with an animal glue medium, either calcium sulfate (gypsum or plaster) primarily used in southern Europe, or calcium carbonate (chalk) primarily used in northern Europe
- Oil – mixed with a drying oil, usually a white lead pigment or an earth color
- Bole - a naturally occurring red clay applied to a surface prior to water-gilding, usually applied on top of a gesso layer

Typically, a panel painting was prepared with a gesso ground. At times, a canvas layer was added to the wood prior to the application of the gesso. With the advent of oil painting, canvas increasingly became a more popular support. However the brittle nature of a gesso ground made it unsuitable for use on the flexible canvas, and so oil grounds became the preferred material.

Mediums for Easel Paintings

- Egg Tempera – egg yolk mixed with a pigment
- Drying Oil – usually linseed, but also walnut and poppyseed
- Distemper – a protein-based paint, such as animal glue or casein (milk paint)
- Encaustic – wax (paintings with wax media are not considered encaustic unless heat has been used)

The majority of easel paintings are either in egg tempera or oil. Early Italian Paintings from the 13th – 15th Centuries were usually done with egg tempera paint. A shift was seen in the 15th century towards the use of oil paint. During this transition period, it was quite common to use both oil and tempera in a painting. From the 15th Century on, oil became the predominant media.

Both tempera and oil exhibit different qualities in texture, thickness and method of application. Tempera is a thin, quick-drying medium, with no build-up of paint or texture in the paint layer. Because of this, tempera paintings were usually created by using small, quick brushstrokes in a cross-hatching pattern to develop the composition. A "wet-on-wet" technique cannot be employed. By contrast, an oil medium imparts a body to the painting, giving the paint layer more of a dimension. The slow drying nature of the oil allows for more reworking of the surface and the use of a wet-on-wet technique.

Pigments for Easel Paintings

- Earth colors - ochres, umbers, siennas, terre verte
- Mineral colors - azurite, malachite, lapis lazuli (ultramarine), cinnabar
- Organic colors - cochineal (derived from insects), Indian yellow, indigo
- Manufactured colors - lead-tin yellow, white lead, verdigris, Prussian blue, vermilion

Until the 19th and 20th centuries, artists had access to a limited palette of naturally occurring minerals, pigments from ore metals, or colors of an organic origin. Until the explosion of "colourmen" such as Winsor & Newton in the 18th century, most pigments were made either by the artist himself or an apprentice in his studio. The identification of the presence of certain pigments can help date a painting. For example, Prussian blue was first manufactured in 1706, and lead-tin yellow was only used up until the 18th century. Most organic colors are considered "fugitive" - prone to changes in color.

Varnishes and Coatings for Easel Paintings

- Natural resins – usually dammar or mastic, but also copal, shellac, amber, sandarac
- Glair – a mixture of egg white and water, used as a varnish for tempera painting during the 13th-15th centuries
- Wax - beeswax applied as a protective coating or to matte down an existing coating

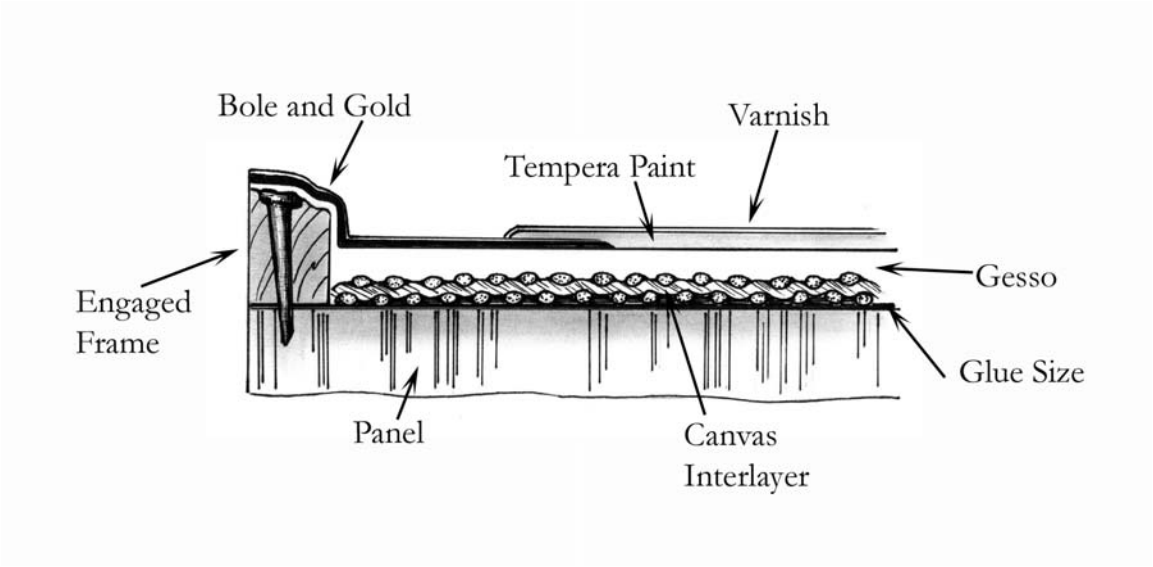
Most paintings before the 20th century were meant to have some kind of surface coating, the use of which is integral to the aesthetic presentation of these paintings. Usually the coating on an oil painting was meant to saturate the colors to give greater richness and depth and unify surface gloss. Tempera paintings were usually given a coating of glair for protection, but this "varnish" did not necessarily change the optical qualities of the paint. Most of the glair varnishes are no longer extant due to previous campaigns of restoration and tempera paintings have commonly been varnished with natural resins, inherently changing the appearance. Very few original resin coatings exist today; by nature resins discolor, undergoing a chemical change causing yellowing and have therefore been removed through previous campaigns of restoration.

Painting Stages and Techniques

Many Medieval and Renaissance treatises were written to provide a guide for artists. Although there were deviations from these guidelines, these historical documents present a good outline for the stages of painting. With research into these historical documents and examination of the painting, insight is given into an individual work of art.

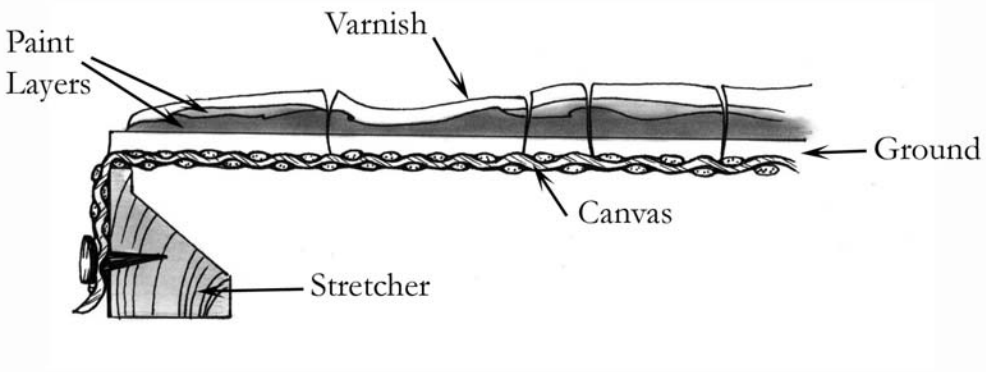
Techniques and Stages for Tempera Panel Paintings

- Panel preparation - seasoning and smoothing of the wood
- Engaged frame - framing elements added to the wood support, will become an integral part of the panel
- Sizing - application of a glue to seal the wood
- Canvas interlayer - application of canvas over some or all of the wood to alleviate damage from the expansion and contraction of the panel, and knots or anomalies in the grain pattern
- Ground - application of many layers of a thin gesso ground to create the brilliant white preparatory surface
- Pastiglia - a decorative technique involving the gradual building-up and carving of gesso for gilding or painting
- Underpainting - thin paint applied to the ground to layout the basic composition
- Bole Application- application of a clay to the ground layer to prepare for gilding
- Water Gilding - application of gold leaf to the bole, usually then burnished to a high polish
- Tempera Painting - dispersion of pigment in egg yolk, applied in thin layers, usually in a cross-hatching pattern to build up color and form
- Sgraffito - a decorative technique involving the scraping away of paint layers to reveal water-gilt areas underneath
- Mordant Gilding - application of an oil size and subsequent gilding for further decoration, such as the depiction or embellishment of embroidery on drapery
- Punching - a decorative technique involving the use of punches to create designs in the gilded areas, such as for the depiction or embellishment of halos



Techniques for Oil Painting

- Support preparation - seasoning of the wood or stretching of the canvas
- Sizing - application of glue to seal the wood or canvas against oil penetration
- Ground - application of either a gesso or oil ground to seal the canvas or wood and to create a smooth surface on which to paint
- Imprimatura - a paint layer following the ground that would seal the oil-absorbent gesso layer
- Underdrawing or Underpainting - planning stage of the composition, either in pencil, crayon or paint
- Painting - dispersion of pigment in a drying oil, possibly incorporating some of the following techniques
    - Scumble - a thin but opaque paint that is dragged across underlying paint
    - Glaze - a thin but transparent paint that is dragged across underlying paint
    - Impasto - a thick opaque textured area from the application of a heavily-bodied paint
- Varnishing - application of a natural resin to saturate the paint colors and protect the surface



Conservation

The history of painting should be studied along with the history of restoration. The deterioration of paintings was an observed fact by many artists from the 13th century to present day, and many artists were asked to restore paintings by the previous century's masters. Therefore the majority of paintings have been restored to a certain extent at one point in its history.

In the last 30 years, restoration has become only one part of what is now known as the field of fine arts conservation. Conservation is a blanket term used to encompass preservation, examination, documentation and finally, restoration. Conservation is considered a more holistic approach to ensure the safety of art for the future.

- Preservation – to prevent or delay deterioration
- Examination – to determine the structural and aesthetic soundness of a work of art, to determine the methods and materials of fabrication for that work of art
- Documentation – to record the current condition and fabrication of a work of art through photography, microscopy, radiography, ultraviolet/visible fluorescence and infrared reflectography
- Restoration – to stabilize structural insecurities or weaknesses, to recover the original paint surface by careful removal and reduction of old varnishes and retouching, to reintegrate old losses and damage to present an overall visual unity

Conservation Procedures

- Selection of project – a collaborative process that is based upon conservation and curatorial concerns for structural weakness and aesthetic presentation, and priorities for loans, exhibitions or research
- Examination – determine condition and fabrication of the artwork and extent of previous restoration, determine stability of all materials for future conservation treatment
- Documentation – written report and photography to record findings from the examination process

After the above procedures have been reviewed with the curator, the conservator may undertake some or all of the following, depending on the needs of the specific artwork.

- Consolidation – adherence of insecure areas of paint by introducing an adhesive
- Cleaning – removal or reduction of dirt, grime, discolored varnish and retouching through solvent mixtures or mechanical means
- Facing – application of a tissue and adhesive to the front of the painting to secure the paint layer prior to corrective structural procedures
- Transferring – an extremely invasive treatment rarely done today, entailing the removal of the original canvas or wood support, leaving the paint and/or ground layer, followed by readhering the layer/s to a new support
- Cradling - application of a wood latticework on the reverse of a panel painting to prevent warping, prior to cradling the wood support is usually thinned
- Lining - a procedure where a new canvas is adhered to the reverse of the original canvas for support
- Lining removal – removal of an old lining canvas which had been adhered to the reverse of the original canvas for stability or strength, usually done because of adhesive failure that results in delamination between the original canvas support and the lining canvas

- Varnishing – application of a saturating varnish of either a synthetic resin or a stabilized natural resin varnish
- Filling – addition of a putty-like material to areas of paint loss
- Inpainting – the use of either synthetic or natural resin medium restoration paints that are applied only where areas of paint have been lost in order to restore visual unity to the painting
- Final Documentation – written report and photography to record all aspects of treatment

Causes and Results of Deterioration

Over time, most paintings have experienced some sort of damage.

- Natural aging – cracking of the paint layer related to expansion and contraction of the support and eventual paint loss, increasing transparency of the oil medium revealing previously hidden changes in the composition (pentimenti), weakness of the canvas support resulting in tearing or draping, weakness of the wood support resulting in warping, splitting and cracking
- Relative Humidity – fluctuations cause expansion and contraction of the support, with subsequent warping, cracking and flaking of the paint layer
- Water – shrinking of canvas support causing tenting and blanching of the paint and varnish layers
- Environment – atmospheric dirt and grime accumulate on the surfaces of paintings, acidic pollution products from combustion of fossil fuels can cause chemical changes in materials
- Light – fading of light sensitive pigments, discoloration of varnishes and paint due to ultraviolet light exposure
- Heat – blistering from fire or point sources of light
- Temperature - Causes changes in the relative humidity, slackening or tightening of canvas, warping of wood
- Accidental damage - tears, bulges, dents, paint losses from falling, mishandling, improper transit

A conservation treatment gives many results: a more stable paint layer and support, a more appropriate aesthetic presentation through careful cleaning, and a more unified painting through the reintegration of the paint losses. It is not possible to return the painting to its original condition, though, because lost paint cannot be retrieved, and faded colors cannot be revived. However through careful preservation, documentation and restoration, conservators can help stem the tide of deterioration and ensure that the painting can be enjoyed for many years to come.

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Written by Noelle Ocon, Associate Conservator of Paintings
Drawings by David Findley, Former Chief Conservator
North Carolina Museum of Art

Within the field of conservation, four main diagnostic techniques are routinely used during the examination, documentation and restoration of a work of art. These procedures are used to gather information about the materials and techniques used by the artist to construct the painting, to identify materials applied later (such as restorations), and to diagnose the many problems that paintings develop. Other types of testing procedures and equipment are used in various situations, but they will not be explored here.

The first three techniques, ultraviolet/visible fluorescence, infrared reflectography, and x-radiography, fall into the "non-destructive" category, causing no change to the artwork. These three procedures rely on the properties of the electromagnetic spectrum, and are essentially light waves. Photographic processes and digital imaging assist our eyes, which are limited to "visible" light, to "see" other ranges of light.

Ultraviolet/Visible Fluorescence

Ultraviolet lamps are commonly called "blacklights". Materials on the surface of the painting fluoresce visually to UV light and these differences can be characterized. Conservators frequently can identify certain pigments used by the artist (i.e. rose madder), natural resin varnishes and retouchings applied in past restorations. Because of limited penetration, UV light is only useful to identify materials on the surface or uppermost layers of a painting. For instance, if a painting has an old, thick layer of dammar varnish, the conservator will not be able to see anything underneath the varnish using ultraviolet light (such as the original paint layer). The conservator directly views the painting while it is illuminated solely by the ultraviolet light and a photograph can be taken to record this information.

Infrared Reflectography

Using infrared light to examine a painting, the conservator can often see what is directly under the surface of the paint layers. This can be very useful in identifying restored damages, finding changes in the composition, and viewing the underdrawing applied by the artist. The infrared light penetrates the paint surface, and is reflected by the ground layer of the painting. However, some of the infrared is absorbed by carbon-containing pigments such as inks, charcoals and other drawing materials and so do not reflect back. This infrared light is invisible to the human eye, although we can feel it as waves as heat. The conservator must use an infrared-sensitive device to view these reflections – equipment that was initially designed for military applications such as night vision scopes. At the North Carolina Museum of Art, a special camera with an infrared-sensitive detector is used. This information from the camera is fed into a monitor for observation and can then be saved into the computer for further study. For the best resolution, the camera must be close to the surface of the painting – distances range from 4" to 36". Therefore, numerous images must be taken to examine the entire painting. Using the computer these separate images are then stitched together to create one large image of the entire painting. Computer manipulation can change the image to accentuate or diminish certain details in order to obtain different information.

X-radiography

In contrast to the ultraviolet/visible fluorescence which shows surface phenomena and the infrared which shows phenomena under the paint surface, X-rays penetrate all the way through a painting: varnish, paint, ground, canvas support, wooden panel or stretcher. This is sometimes very useful to see things within the structure of painting that are not visible by looking at the external surface. Conservators often find changes in the composition of the painting or restored damages. Conservators can also analyze the construction of the support, such as identification of the type of wood and construction method used in a panel. X-rays pass through the object but are slowed or blocked by heavy metals such as lead-based paint and iron nails. To take a radiograph, the conservator lays a film sheet directly on the painting and shoots the x-rays through the painting to expose the film. After developing the film the conservator can read the image. The process is identical to medical x-ray procedure. Since the 14" X 17" film is laid directly on the painting, creating a 1 to 1 image, many separate sheets of film are necessary to record an x-ray image of a large painting. Like infrared, these separate x-ray sheets can be scanned into a computer and stitched into one image. Computer manipulation can change the image to accentuate or diminish certain details in order to obtain different information.

Microscopy

A great deal of information about the condition and construction of a painting can be garnered by a close look at the surface. Conservators employ several types of microscopes according to what information is desired. Less powerful microscopes are routinely used to examine the surface of paintings to explore crack development, deposition of dust and dirt, and identifying later additions or restorations. The conservation lab here uses a microscope initially built for use in eye surgery, with magnification ranging from 4X to 40X. Stronger microscopes are often used to identify pigments, mediums, and the order of paint application with magnification ranges of 10X to 100X.

One microscopic technique involves the observation of a cross-section of paint. This small cross-section can reveal information about the layering of varnish, paint and ground layers. This is considered a "destructive" technique, because a small sample of paint, about the size of a dull pencil lead, must be removed. When mounted correctly, and examined under very high magnification, a cross-section reveals the “layer cake” application of the painting’s materials. Ultraviolet/visible fluorescence may also be employed through the microscope to examine the tiny sample. Pigment and media analysis can be done, and restorations can be clearly identified in some cases.

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