

Technical Imaging of Paintings

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CONSERVATORS employ a number of examination and imaging techniques to explore the multiple layers of a painting, layers that are both visible and invisible to the naked eye. Some of these approaches require the simple use of unusual lighting angles, while others involve very specialized equipment capable of producing or capturing electromagnetic wavelengths above or below the narrow band of the visible spectrum. While one technique may assess the nature and condition of the varnish and restoration layers lying on the surface, others are capable of recording hidden layers lying below the visible image.

It is best to call a conservator and describe what you are looking at and what you are searching for, in order to find out which technique may best answer your question. WACC has the capability to radiograph paintings, but there is sometimes confusion in understanding just what an X-ray image can or cannot provide. Radiography is not the magic solution to all problems, and sometimes a simpler, less expensive examination technique is the better choice. A question might be answered with one technique, or several in combination. Occasionally the results are disappointing and no answer is possible, while other cases indicate scientific analysis of the materials is needed.

Ultraviolet Light The most commonly used lighting tool for paintings is a long-wave ultraviolet lamp. This wavelength, just beyond violet in the visible spectrum, is used to look at the surface of a painting. Ultraviolet (UV) light causes aged varnishes to fluoresce or glow, with various classes of coatings presenting different color fluorescence. Aged natural-resin coatings, such as damar or mastic, are still the most commonly found on artwork needing cleaning. In natural light these aged resins are yellow or brown in color, but in ultraviolet light they glow a yellowish-green. Depending on the age of the coatings, their thickness or number of layers, the underlying paint film and older retouches may be highly detectable or barely visible through the fluorescing varnish. When buried under old varnish, discolored retouching often looks brown or muddy in UV light, but may not be easily detectable, so confirmation in strong normal light is necessary. When the retouching sits closer to the surface it does not fluoresce, but will absorb the UV rays, looking dark purple. An aged synthetic resin fluoresces pale blue, and the occasionally-seen shellac fluoresces orange. It is important to remember that most new or recently applied varnishes will not fluoresce. It may take more than 10 years of aging before a resin alters enough chemically to create the by-products that cause UV fluorescence.

Certain pigments also have signature fluorescences—madder or alizarin red show pink in UV, for instance, and zinc white (which has been used in ground preparations since the 19th century) appears yellow. The examination of faded or abraded inscriptions on the backs of paintings can also be

Figure 1



An identical section of an oil painting photographed in normal light (top) and in raking light.

aided by ultraviolet light. Iron gall ink, a common brown writing and drawing ink used from medieval times through the 19th century, often fades from visibility, but remains detectable under ultraviolet light.

When appropriate, WACC provides clients with before-treatment UV photos to show the extent of previous retouching, and conservators sometimes rely on UV photos during treatment. While a powerful, heavy-weight UV lamp is used at the Center, very affordable, portable models are available. Every museum and serious collector of paintings should have a long-wave UV lamp and become familiar with its use. Beware of unscrupulous dealers. They sometimes coat their paintings with a UV blocking varnish that totally obscures the paint surface, hiding severe damage and massive cosmetic work.

Raking Light While ultraviolet light examinations are routine for almost every painting, there are several normal light techniques which can produce useful evidence. Raking light, a strong oblique-angled light from one side of the picture, can record condition problems such as severe cupping, flaking paint or distortions in a canvas. [Fig. 1] Such photos are sent to clients to show the extent of damage, especially if lining or other structural courses of action have been proposed. Raking light can also be useful in recording the topography of anomalous underlying brushwork, whose presence may record changes made by the artist or may indicate a totally reworked painting. Such discoveries are often followed with radiographic films to determine the extent of the alterations or the existence of a hidden painting.

Reflected Light Another technique that also relies on a specific angle of illumination is reflected or bouncing light. Photo lamps are set 90 degrees (or exactly perpendicular) to the picture's surface to catch the surface reflections. Although rarely used, reflected light can show off variations in gloss, thickness and application in a different way than raking light. It is especially useful when comparing a given painting with known works by a painter whose surfaces display particular surface phenomena. We recently provided reflected-light images of the Hood Museum's large Perugino altarpiece, which shows the flat, thinly-painted flesh areas against the thickly painted robes, a phenomenon seen on early Italian oil-painted panels, and especially noted on Perugino's surfaces.

Infrared Light The above techniques rely on providing the lighting to a painting's surface, which can then be recorded with either a film-based or digital camera. As digital photography is becoming the industry standard, conservators have been faced with changing from black and white film, which has long been the archival standard in our code of ethics, to digital photography, where long-term storage is still being perfected. This pressure to convert to the newer technology has created a more expensive transition in the two remaining imaging techniques.

For the last few decades, it has been possible to examine hidden aspects of artists' working methods using infrared wavelengths of light (those

beyond red in the visible spectrum). Previously, materials which absorb or reflect heat were differentiated using heat-producing lamps (infrared or incandescent) and a television camera fitted with special filters. Images from the camera were transmitted to a black-and-white television monitor, where they could be manipulated by altering the focus, contrast and brightness. Photographs taken off the monitor were not publishable due to the rolling lines typical of television systems. If useful information was detected, a photograph was taken using infrared film and printed on black and white paper. WACC now produces IR images using a dedicated digital infrared camera and specialized filters. Manipulation of the image can now take place on the computer, and multiple exposures of the surface can be merged to produce an infrared montage of an entire painting.

The principal use of infrared imaging is for the detection of black preparatory underdrawing lines against a white or pale ground layer. [Fig 2] The camera penetrates through the paint film, rendering the colors more transparent or invisible. The heat from the lamps is absorbed by any dark material such as graphite, charcoal or black ink, and reflected by any white surface. Infrared examination is therefore a natural for the study of early Italian paintings, which are traditionally executed on white gesso grounds, and often have images and perspective lines drawn on the surface prior to painting. This examination technique works on any painting having a contrasting pale ground and detectable underdrawing lines, but is of no use on dark-color ground layers, such as those of the 17th century. Old losses can sometimes be seen if a restorer used a filling putty paler than the surrounding original ground color.

Standard infrared viewing (lights in front of the painting) or transmitted infrared (lights behind the painting) can sometimes also be used to detect painted-out signatures or artist changes, but only if the information is much darker than the surrounding area. Just because you want to find a signature does not mean there is one.

Radiography Unlike all the above techniques, radiography is not a photographic procedure, but a clinically-based diagnostic technique, using electromagnetic energy found beyond ultraviolet light in the spectrum. Paintings are normally shot at exposures far smaller than medical radiographs, and the low dose of electromagnetic radiation does not hurt or alter the painting materials. Precautions are necessary, of course, to protect the operator and secure the zone where the machine is used. The state inspects the space used for radiography and issues a license to the conservation facility for operating the radiographic equipment.

X-ray film primarily records the structural elements of a painting and the dispersion of lead white, the principal white pigment used by painters for centuries. The sheet of film is placed against the paint layer to produce the sharpest image of the artist's working techniques. Areas of pentimenti, seen as colors, brush-strokes or shapes below the final paint layer, are considered indications of an original work of art, as copyists rarely adjust an image.

Figure 2



Museum of Art, Rhode Island School of Design, Museum Works of Art Fund.

Detail of a 16th-century Flemish portrait. Black-and-white infrared image reveals preparatory drawing below the paint layer.

figure 3



A horizontal landscape by Whistler (top), and the vertical self-portrait that x-ray inspection discovered beneath it.



While such changes are often visible to the unaided eye, they are best detected through radiography, where even hidden levels of paint are recorded. The most spectacular radiographs are those that show one painting over another, as in the example of a horizontal landscape by Whistler which revealed a vertical self-portrait of the artist below the surface. [Fig. 3] Although rare, this phenomenon happens when an artist reuses his support, or, on occasion, when forgers employ a period panel or canvas as part of their trickery. Repaired tears and holes on the canvas or panel support, or losses in the ground layers, are easily spotted with an x-radiograph, and cut-down edges and transfers can also be confirmed.

X-ray films are also used for scholarly study when an exhibition or publication on a particular artist is in process. It is useful to compare x-ray images of a number of paintings reputed to be by the same hand, and attributions can come and go based on such studies. Along with infrared comparisons, radiography is a major tool in the examination of the technique of an individual artist and/or his studio.

Clients sometimes believe radiography will reveal everything they ever wanted or needed to know about their art work. Alas, if that were true, we would x-ray everything. Radiographic films of a painting can provide some very interesting data, or they can tell you nothing you don't already know. Radiography is an expensive technique, involving conservator and technician time, film and processing, as well as digital transfer and merging. The cost increases based on the size of the picture. We x-ray no more than one in 50 to 70 paintings that come to WACC, on either the recommendation of the conservator or the request of the client.

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