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SCIENCE SERVING THE FINE ARTS

ROBERT L. FELLER



Does science have a proper place in the field of the fine arts? There are persons who will say, very positively, "Not at all!" The disclaimers are perhaps hasty and do not fully understand the role that scientists intend to play. Chemists and physicists certainly do not expect to place pictures in front of some sort of electronic black box that will conveniently ring a bell in the presence of a fake or forgery. Nor do they intend to sit in judgment on esthetic questions; such is not their special training. Scientists, however, are well acquainted with the properties of materials. Is it not wise, then, to consider their counsel in preserving material objects and in developing more durable substances? Leading museums of art all over the world now include technical advisers on their staffs. This article will discuss the various ways in which men of science are able to serve the fine arts.

THE METHOD OF SCIENCE

The method of science is a "way of doing things" which has been applied with great success to diverse problems in health, medicine, agriculture, machine design, and so on. At its very base, science is founded upon careful observation and the gathering of facts. In astronomy, for example, countless observations were made before it could be demonstrated that the motion of the planets followed a regular pattern. In the fine arts it will be equally necessary to record and study the durability of pictures, painted and treated in various ways, before sound practices in painting and conservation can be firmly established. For many years it was not the custom of museums to keep detailed records of what a restorer did to their pictures. It was therefore difficult to "learn from experience" whenever a particular treatment had detrimental results. At present, much more attention is being given to observing and recording such facts. At the last meeting

of the Art Technical Section of the American Association of Museums a major portion of the program was devoted to this subject. Careful study of these records will contribute much toward building truly scientific techniques in the care of museum collections.

Scientific knowledge grows by systematic study. A definite intent, or purpose, is needed to guide experimentation, for random facts do not constitute science. Returning to the example of astronomy: when it was found that the seasons were reasonably well-ordered, the lengths of the day and of the year were measured with increasingly greater care, to determine just how regular they really were. As a result of these investigations, it is now possible to measure time precisely and to predict tides and eclipses far in advance. In the field of fine arts: when it was noticed that ancient marble and ivory fluoresced under ultraviolet light, this observation was carefully checked with thousands of objects. It was essential to determine if this was definitely a characteristic of old materials. Could the phenomenon therefore reliably detect modern "restorations" and fakes? It was found that modern pieces do not generally glow under ultraviolet light in the same manner as old materials. Because prominent museums supported these systematic investigations, their present staffs are often able to detect false items which might otherwise pass unnoticed. Careful study and repeated experiments had to precede the practical result, however; this is generally the case when applying science to practical problems.

In their investigations, scientists search for causes; this is another aspect of the method of science. For example, Sir Alexander Fleming must have asked himself, "Why should a certain strain of *Penicillium notatum* retard the growth of bacteria?" He found that the answer was not due to the mold itself, but to a substance yielded by it. His particular search for a cause gave us the wonder-drug, penicillin. In the field of fine arts curators

often wonder about the cause of fading in a particular picture, the cracking in another, the yellowing of varnishes. Here, too, the causes can be found. A scientist is especially trained to track them down. However, general questions require a long time to answer, specific ones are easier. Is the ultramarine in a picture the natural or the synthetic variety? Is the synthetic just as resistant to fading? Does the ground or underpainting in a picture contain titanium white? Were lead pigments lost in cleaning the picture? The answers to these questions can be very definite and are relatively easy to determine.

It should be pointed out, however, that a team of experts is needed to interpret the facts in the light of historical as well as scientific knowledge. For example, what good would it have done to discover, by spectroscopic methods, that Van Meegeren's faked Vermeer contained cobalt blue, if someone had not known that this pigment was modern and could not have been used by Vermeer? Notice, too, that the investigators were dependent on the previous systematic study of the pigments likely to be found in the work of a particular artist. At one time perhaps it was claimed that the study of the pigments used in old paintings was academic and could have no practical use. However, we never know in science when our facts will prove valuable. When Mme. Curie began her study of radioactivity she had no idea of its utility or of the practical consequences.

FACTS AND THEORIES

Why is a competent scientist so sure of his facts? In part, it is because the method of science involves the use of controlled experiments. How often have we heard an artist complain that, at one time, he tried a technique and it worked very well, but that he has never been able to repeat it? What could have been different about that successful time? Again, a scientist's training is especially directed toward solving such problems. Perhaps the day was very humid, or perhaps something remained in the "clean" paintbrush used. A scientist controls these variables. In the work at Mellon Institute, for example, our samples of varnish are examined in a special room kept constantly at a definite temperature and humidity. Paints and varnishes are coated, not by use of a brush, which might well be contaminated, but with a stainless-steel paint-spreading blade.



X-RAY PHOTOGRAPH OF AN OIL PAINTING

This is an artist's sketch, simulating the appearance of a typical photograph taken with x-rays. Note the losses in the cheeks and forehead and the cracks that exist in the original paint. Only the areas painted or underpainted in white lead are revealed. Retouching of lost areas was done in tinted varnish, not paint. Right eye was apparently painted in earth colors containing no white lead.

Someone may ask at this point, "Are scientists really sure of their facts: are they positive of what an atom looks like?" There is an important difference here. Atoms and molecules are pictured as part of a theory used to explain facts. Theories and explanations guide our thinking until a better idea comes along; they are not infallible. At one time the effect of drinking an extract of poppy seeds was explained by saying that the goddess Ceres created the flower to help her forget the loss of her daughter Proserpine, who had been carried off by Pluto. Chemists now know that the sleep and forgetfulness is caused by alkaloids, useful as drugs, present in the seeds. The explanation has changed, but the fact still remains that taking the extract will have certain definite effects.

If a technical adviser states that a picture has been painted with the ancient pigment, lapis lazuli, he will be certain. However, he is well aware that it is another problem to account for this fact. The co-operation of a team of experts is needed. The advice of historians, authorities on the work of a particular artist, and conservators with much experience in the care of paintings is essential to the proper interpretation of the facts.

IMPROVING METHODS AND MATERIALS

After careful observation and study, it is often possible to recommend improved ways of doing things. Illustrations are the

air conditioning of galleries and the systematic recording of the treatment given to pictures. Besides improving methods, today there also exists the wonderful possibility of creating new materials. Modern chemistry is able to synthesize entirely new substances: synthetic fibers, plastics, special glasses, artificial rubber, and the like. Perhaps the most uncultivated area of all in the application of science to problems in the fine arts has been in this matter of introducing new materials. In painting, for instance, most of the materials in use today have been traditional for hundreds of years.

The development of a new and useful substance is always a difficult task. With artists' materials there is the added restriction that they must possess great durability. There is also the problem of handling quality. By this is meant the facility with which an artist can paint or carve in his medium. An example of the importance of handling quality, from history, is the popularity with which Van Eyck's oil-painting technique was received in the fifteenth and sixteenth centuries. The oil medium allowed the artist much greater freedom than was possible with the egg tempera that artists were then using.

Whereas scientists are able to recommend very durable substances that might be tried by the artist, these are generally found to be difficult for him to use without special modification. Industry is constantly seeking new materials, but seldom with the artist in mind. It is to fill this important gap in the application of science to the fine arts that the trustees of the National Gallery of Art recently established a fellowship for broad research at Mellon Institute. The fellowship's first problem will be the development of an artists' varnish, using synthetic resins that will not crack or yellow as readily as do varnishes made with natural resins. Improved materials for supports and grounds may be investigated later. Orlon fiber and chemically-treated wood have already found use in place of canvas and natural wood as supports for pictures. These and many other materials will be appraised by many exacting tests in the research undertaken by this unique fellowship.

Some new materials with which artists

Dr. Feller holds the National Gallery of Art fellowship at the Mellon Institute of Industrial Research. Appointed in December 1950, he is currently investigating the permanence of artists' materials to find new materials and techniques for use in the fine arts, both for original work and for the conservation of museum objects. A graduate of Dartmouth College who took his advanced degrees at Rutgers in physical-organic chemistry, Dr. Feller's favorite hobby is drawing and painting.

have experimented in painting are plastics such as Vinylite (polyvinyl acetate) and enamels such as Duco. Synthetic waxes have also been used for painting in wax-emulsion techniques and as adhesives and moisture-proof coatings in the conservation of museum objects. One of the experiments most interesting to the author, as a chemist, was the attempted use of ethyl silicate for mural painting. This substance quickly decomposes in the presence of moisture to form silica, the material found in sand and quartz. Think of painting in a medium that would become enamel-hard without baking or firing! Unfortunately, considerable difficulty has been found in the technical handling of ethyl silicate; it often quickly solidifies in the container before the artist has a chance to use it. Perhaps, however, this fascinating material, or a similar one, may some day be modified and developed especially for the artists' needs.

SCIENTIFIC TOOLS IN THE MUSEUM LABORATORY

The method of science has been outlined in considerable detail: the gathering of facts, the systematic seeking of causes or possible explanations by means of controlled experiments in the laboratory, the suggestion of improvements based on the knowledge gained. Let us now consider the successful applications where science has already been of great service in the care of museum collections. The two most highly developed and widely used applications are the identification of pigments and the use of x-ray photography. The use of ultraviolet and infrared radiations has also been of great value, but these have not reached the stage of development that the first mentioned have. By photographic methods we are able to learn many valuable facts without even touching the work of art. As mentioned previously, the fluorescence of aged substances under ultraviolet radiation enables repaints and incompletely removed old varnish to be detected in paintings. Because relatively new material does not fluoresce as much as does aged substance, restored areas of marble and ivory sculpture can also be detected in this manner. Infrared photography, on the other hand, often permits us to see through dirty yellow varnish and thus to discover signatures that have faded or have been partially removed.

X-rays are stopped by heavy metals, such as lead. They thereby cast a "shadow" on the photographic film wherever white lead or other heavy-metal pigments have been used in a painting. It is possible in this fashion to study the underpainting of the masters, to detect retouching, and to locate cracks and losses of original paint.



CARDINAL McCLOSKEY
(The first American Cardinal)
BY GEORGE PETER ALEXANDER HEALY
National Gallery of Art



X-ray shadowgraph shows that the artist painted over his first profile view of the head in the portrait opposite. The medallion also was painted out. A cross shadow is cast by the canvas stretcher.

When an x-ray examination was made of Van Meegeren's faked Vermeer, the outline of another picture was found. Van Meegeren had purchased an obscure seventeenth-century painting upon which to work, because the one thing that could not be faked was an old canvas. He knew that x-rays would reveal the old picture beneath his own, but was unable to scrape every last trace of it away before beginning the new painting. Dr. van Schendel, curator at the Rijksmuseum in Amsterdam, had the good fortune to discover a photograph of the very painting that was revealed to be underneath the "Vermeer"! Could an authority on the paintings and style of Vermeer have been as positive as the evidence supplied by these photographs?

Microchemical analysis of pigments requires but a speck of material; only four ten-thousandths of an ounce of pigment is necessary for an accurate analysis. Samples may be taken at the edge of the picture, near the frame, and therefore contribute little harm. In addition, a hollow needle has been especially developed to take a tiny core from a picture, much as an apple-corer removes a cross-section of an apple. By this technique, the various layers of paint and varnish may be examined under a microscope. This is much the same as a geologist would investigate what is below the surface of the ground, without digging up everything. Spectroscopic analysis also requires a very small sample. In this process, the samples are burned in a carbon

arc and the light passed through a prism. The colors in the flame are spread out just as the spectrum of the sun is when sunlight is passed through a prism. Although Van Meegeren was careful to choose the natural variety of ultramarine, lapis lazuli, in faking the work of Vermeer, spectrographic analysis detected traces of cobalt blue, a modern pigment that must have accidentally contaminated his paint.

The analytical methods just described have proved indispensable to the solution of problems in many fields. It is hoped that museums will take further advantage of these techniques in the future. It would also be advantageous if support would be given to long-term investigations, such as improving the methods of cleaning and relining pictures. At present, extensive studies are being undertaken by relatively few museums throughout the world. The newly formed International Institute for the Conservation of Museum Objects will endeavor to co-ordinate and further this work. This organization deserves whole-hearted support in its effort to bring scientific techniques into greater service.

By illustrating the method of science with appropriate examples, this article has attempted to show that analytical, photographic, and chemical techniques play a vital role in the care of museum collections. It is hoped that this discussion will lead to a better understanding of the opportunities inherent in the application of science in the field of fine arts.